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Military Aviation Review

International

NH-90 roll-out

The first of five prototype NH-90 multi-role helicopters being developed by the four-nation NH Industries consortium was rolled out at Eurocopter France's Marignane factory in September, amid speculation concerning the project's future prospects. As the major NH-90 partner, France is currently committed to contributing 41.6 per cent of its FF9.6 billion (\$2 billion) fixed-price R&D costs, and of the FF100 billion (\$21 billion) production costs for total planned production of 544 tactical and 182 naval versions. Recent FF8 billion (\$1.66 billion)

defence procurement economies by the French government, however, have included demands for a programme review to reduce these totals or find cheaper alternatives. Current NH-90 requirements comprise 160 TTH tactical and 60 NFH naval versions for France, 234 TTHs and 38 NFHs for Germany, 150 TTHs and 64 NFHs for Italy, and 20 NFHs for the Netherlands. There now seems little chance of these totals being realised. Standard NH-90 powerplants are RTM322-01/9 turboshafts, apart from those aircraft for Italy which will be fitted with GE T700-T6Es for EH101 commonality.

Europe

BULGARIA:

New equipment acquisitions

Twelve Mil Mi-24 attack helicopters were included in \$500 million worth of arms purchases from Russia last summer. They are supplementing about 20 Mi-24D 'Hind-Ds' already operating with 13 Helicopter Regiment of the Bulgarian air force (Bulgarskite Voenno Vasdushni Sily) at Stara Zagora.

Four Zlin 142 and four Yakovlev Yak-18T piston-engined trainers of the paramilitary Directorate of Youth Training have been transferred to the BVVS Air Academy at Dona Metropoliya. While still operated by the DYT, they will provide students with about 20 hours of primary instruction before basic and advanced jet tuition on the Academy's Aero L-29 and L-39ZA jet trainers.

CZECH REPUBLIC:

MiG-21 upgrade plans frozen

Although the Czech Defence Ministry insists that no funding would be available for buying new fighters until at least 2005, the US is making renewed offers of surplus early model Lockheed

Martin F-16s and McDonnell Douglas F/A-18s to what it regards as "the leading Eastern European country in meeting conditions for NATO membership". Similar offers of up to 30 F-16A/Bs are also being made by the US to Poland, Hungary and Slovakia. Meanwhile, the Czech Defence Ministry has suspended plans for the prototype avionics upgrade of two of the air force's 88 MiG-21s, for which CKR2 billion (\$76 million) had been allocated, pending early 1996 evaluation of the US price and technical briefings, which include virtual no-cost short-term lease options.

FINLAND:

F/A-18 Hornets enter service

Formal acceptance of the first of 64 McDonnell Douglas F/A-18C/D Hornet multi-role fighters was made at the Tampere/Pirkkala air base – the home of Saab Draken-equipped HavL-Lv (Fighter Wing) 21 – in early November 1995 in the presence of the C-in-C Finnish Defence Forces, General Gustav Haeggland, and senior Ilmavoimat officials. Finland had received four of the seven two-seat F/A-18D combat trainers being supplied in completed form from McDonnell Douglas from the FMk14 billion (\$3.31 billion) contract up to that time. The remaining 57 F/A-18Cs are being assembled from MDC com-

ponents and some locally fabricated parts by Valmet, which will deliver the first of these by the year end.

FRANCE:

Defence economies delay equipment programmes

Cuts of up to 20 per cent in 1996/97 defence equipment procurement planned by the Chirac government to help reduce the national deficit to the EC's 3 per cent of GDP specified ceiling could delay French air force Rafale deliveries by up to 10 years, according to a national defence committee spokesman. René Galy-Dejean said late in 1995 that early deliveries of 86 Rafale Ms for the French navy must be maintained, but some of the Armée de l'Air's 235 required Rafale B/Cs should be replaced by more of the lower-cost Mirage 2000-5s already ordered. Initial deliveries of the 86 Rafale Ms for the French navy will now start two years later, in 1999, followed by the first of 234 Rafales for the AA in 2001-02.

His views were echoed by AA C-in-C Général Jean Rannou, who said that it would have been better if this and the Mirage 2000-5 programmes had not been conducted at the same time. Rafale costs, he added, estimated at FF198 billion (\$39.73 billion) in all in a recent finance committee report, had left the air force with insufficient funds to meet all its financial commitments. To release more funding for the Mirage 2000D and 2000-5, which met immediate AA needs, he therefore made radical proposals in Rafale procurement time scales. These would leave the initial Rafale M (SU-0) production series unchanged, but would cancel the AA's first production batch (SU-1), and defer the main batch of more advanced Rafale versions (SU-2) to about 2010. Stretch-outs of a year or more are also expected in the NH-90, Future Large Aircraft and Boeing E-3F AWACS upgrade programmes.

The 1996 defence budget approved in November at a revised total of FF189.6 billion (\$39.44 billion) included cuts of 7.8 per cent in weapons and equipment totals, to FF94.9 billion (\$19.74 billion). This includes funding for 12 ground-attack Mirage 2000Ds and four Mirage F1CT conversions, plus 23 upgraded multi-role Mirage 2000-5s, but no further Rafales to the 13 previously ordered. R&D funding is included for such joint projects as the NH-90 helicopter, plus \$7.6 million for FLA. A moratorium was placed on further spending for the moment on other programmes, including the Eurocopter Tigre (delaying its production investment phase) and its AC3G-LP anti-tank missiles; and the MATRA MICA, APACHE and future surface-to-air missiles.

The EVS at Goetsenhoven has decorated one of its SIAI-Marchetti SF.260Ms with this special scheme to commemorate 45 years of operations from the base and 25 years of SF.260 activity. The unit's badge is the penguin.

GERMANY:

MiG-29 overhaul plans

Maintenance, overhauls and upgrades of the Luftwaffe's 24 MiG-29 'Fulcrums', taken over from the former East German air force, are now being done by a new Russo-German joint-venture organisation known as the MiG Aircraft Product Support Group (MAPS). Fifty per cent of the MAPS, which is based at Daimler-Benz Aerospace's factory airfield of Manching, near Munich, is owned by DASA, with 34 per cent distributed equally between MiG-MAPO and the ANPK-MiG groups, and the remaining 16 per cent held by Russia's state-owned Rosvorouzhenie arms export/import sales organisation. The first Luftwaffe MiG-29 arrived for maintenance at Manching on 16 October 1995, and MAPS is also looking for business from other 'Fulcrum' operators.

MAPS is now studying upgrades to increase MiG-29 component overhaul lives, currently quoted as only 800 hours for the airframe and 400 hours for the Isotov RD-33 turbofan engines. Powerplant TBOs have been almost doubled in German service by a 10 per cent thrust derating, but DASA's MTU engine subsidiary is working on modifications to achieve a 700-hour TBO at higher power outputs. Other upgrades now being made by MAPS include the incorporation of some basic Western avionics, such as UHF/VHF, TACAN, GPS and IFF.

More Lynx helicopter sought

From original deliveries of 19 Westland Lynx Mk 88 frigate-operated ASW helicopters, the German navy has requested funding for an additional seven to be included in the 1996 defence equipment appropriations. These will be to the latest Super Lynx standards, for commonality with the planned 1998-2001 upgrade of the Marineflieger's remaining 17 Lynx 8s.

GREECE:

US aircraft deliveries

Deliveries were made in late 1995 of two ex-USN Lockheed P-3A Orions and the first of four P-3Bs to the Greek navy. The first six of 12 McDonnell Douglas Helicopters AH-64A Apaches on order were also received by Hellenic Army Aviation.

HUNGARY:

Gripen offset production agreement

The Hungarian air force could be the first export customer for the Swedish JAS 39 Gripen, following a memorandum of understanding in late 1995 between the Budapest government and Saab's parent Wallenburg group. This referred mainly to a broad initial economic programme and industrial co-



operation between the two countries. Nevertheless, it would include evaluation and possible procurement of the Gripen for the Hungarian Home Defence Forces by mid-1996, depending on the successful conclusion of offset contract agreements. These began on 16 November with a Saab contract for production of 11 Gripen structural components by Hungary's Danubian Aircraft Co.

Hungary is reportedly interested in 30 Gripens costing around \$1 billion, with options on 30 more, to re-equip its combat squadrons, although it is also evaluating US F-16 offers and French Mirage 2000-5 bids. Under its joint-venture agreement with Saab, British Aerospace expects to share up to 45 per cent of the production of a NATO-compatible Gripen airframe for any export orders. A Hungarian Gripen contract would probably include several two-seat JAS 39B combat trainer versions, now undergoing initial flight development. Hungary's new combat aircraft requirement is particularly urgent following the temporary grounding of its 11 MiG-23s and 10 Sukhoi Su-22s after several crashes in 1995.

ITALY:

EH101 order finalised

Funding was finally released in October to the Italian navy for its long-awaited contract, worth up to L=1.25 trillion (\$780 million), for 16 EH101 helicopters, with options for eight more. Unlike the 44 RAF and 22 Royal Navy Rolls-Royce/Turboméca RTM322-powered EH101s, the Agusta-assembled versions for the Italian navy will each be fitted with three less powerful General Electric T700-GE-T6A turboshaft engines. Eight of Italy's EH101s will be equipped with Eliradar APS-784, active dipping sonar, Elettronica ECM/ESM and other sensors for ASW/ASV roles, plus four each for radar surveillance/command and control, and utility transport tasks. Deliveries are expected to start in early 1998. Budget allocations were also approved for an increase in Italian army aviation A.129 Mangusta attack helicopter orders from 45 to 60.

C-130J interest hardens

After the RAF, the USAF and soon the RAAF/RNZAF, the Italian air force (AMI) is likely to be the next customer for the new Lockheed Martin C-130J Hercules II tactical transport. Confirmation was expected in early 1996 of an AMI decision to buy 16 to 19 C-130Js to replace 14 C-130Hs which have been in service since 1972. Some L=7,000 billion (\$4.4 billion) has been earmarked in a new 15-year procurement investment programme for C-130J and later acquisition of 32 European Future Large Aircraft, in which programme Italy is a partner. An Italian C-130J order is likely to supersede an earlier AMI requirement for another four



The small Cyprus National Guard air wing operates a fleet of helicopters in the southern, Greek section of the divided island. Support and reinforcements are available from the Greek air force. The air wing currently operates four SA 342M Gazelles armed with HOT anti-tank missiles (above), two Bell 206Bs (below), two MD-500s and two Mil Mi-2s recently acquired from Poland.



C-130Hs, for which funding had recently been sought. Interest in the C-130J is also being shown by the Royal Saudi air force, which is discussing buying up to 70.

Additional funding of L=2,000 billion (\$1.26 billion) has also been allocated in the new long-term defence plan for the acquisition of two airborne early warning aircraft for the AMI, which could be based on C-130 platforms.

NETHERLANDS:

Fokker 60U prototype flies

The first of four stretched Fokker 60U twin-turboprop utility transports on order for the Royal Netherlands air force made its initial flight from Schiphol on 2 November. The extended fuselage and large side-load door will allow the RANAF's new

transports to airlift two F-16 PW F100 powerplants and other freight. Delivery is planned to start to No. 334 Sqn in May 1996.

NORWAY:

ECM Falcon upgrade

Condor Systems of San Jose, CA, has received a Norwegian government contract to upgrade the electronic warfare suites of two RNoAF twin-turbofan Dassault Falcon 20s used for ECM and jamming operations. Working with Condor Systems on the integration of equipment developed by the Norwegian Defence Research Establishment are AEL-Cross Systems, of Alpharetta, GA, which is supplying a five-transmitter version of its Crossjam 2000 equipment, and BTG of Vienna, VA, with responsibility for the integrated control and display software.

Aircraft installation and modifications are being done by Aeromet at Tulsa, Oklahoma.

PORTUGAL:

Surplus F-16 purchase discussed

Negotiations with the US took place in 1995 by Portugal for 20 ex-USAF Block 15 F-16A/Bs. These would double its recently-acquired F-16 inventory, comprising 20 new-build Block 15OCU Fighting Falcon, delivered in 1994-95. Nine combat support helicopters are also being sought for the Portuguese army's recently formed airborne battalion.

The An-26Z-1 is an EW/Eltint 'Curl' variant in service with the Czech air force. Antennas for the system are housed in underfuselage fairings and large sponsons.





RUSSIA:

Beriev Be-200 about to fly

Completion by the Irkutsk Aircraft Production Association in Russia of the prototype Beriev Be-200 multi-role twin-turbofan amphibian was expected in time for it to start its flight development in December. Beriev at Taganrog is main partner in the Betair group, a joint stock private venture which also includes the Irkutsk factory, and fiscal backing from Russia's Financial Technological Consortium, Incombank, the Ukrainian Promstroibank, and the Swiss ILTA Trade Finance Company.

While there is no government funding for the Be-200 programme, the project is mainly aimed at a requirement from the Russian Federal Forestry Service and the Ministry of Emergency Situations for up to 75 aircraft in this category between 1997-2005 for firefighting and search and rescue. Many other utility roles are also envisaged, and a letter of intent from the Forestry Service for an initial batch of 25 Be-200s has facilitated the acquisition of finance for this programme.

As a scaled-down version of the mainly military Beriev A-40 Albatross amphibian which has been flying in prototype form for several years (although so far without orders), the 42-tonne (46.3-ton) Be-200 is powered by two 16,534-lb (73.55-kN) Zaporozhye/Progress D-436TP turbofans above the centre fuselage. These may be exchanged for Allison GMA-2100 turboprops for export versions, but joint US/Russian navigation, flight control and EFIS avionics by AlliedSignal and NIIAO will be standard.

A little known type in French military service is the Aérospatiale SN.601 Corvette. This example is used by the central trials unit CEV on training flights and staff transport.



Seen at Tallinn in service with the Estonian border guards are a Let-410UVP (left) and Mil Mi-2 (right), both wearing civilian registrations. The Mi-2 shows obvious signs of its previous ownership by DOSAAF, the Soviet paramilitary flying training organisation.

remainder following at a similar rate over the next three years to supplement the EdA's 69 remaining EF-18A/Bs. Unlike these later production Hornets, the ex-USN F/A-18s are not equipped to launch AGM-65 Maverick or AIM-120 AMRAAM missiles, or for night strike operations.

As a Eurofighter partner, Spain's acquisition of more Hornets was not good news for the rest of the consortium, especially as the Defence Ministry in Madrid confirmed in a surprise announcement in November that consideration was being given to withdrawing from the four-nation project. Spain had already reduced its original requirement for 100 Eurofighters to 82, and the additional Hornets could reduce its EF 2000 needs still further. A Spanish Eurofighter withdrawal could do irreparable damage to the programme, while incurring cancellation costs quoted as about Pts150 billion (\$1.22 billion). The Madrid authorities, however, have emphasised that a decision was not expected for some time.

SPAIN:

Ex-USN Hornets ordered

Spain's Ejercito del Aire (EdA) has become the first customer for surplus early model ex-US Navy McDonnell Douglas F/A-18A/B Hornets, now withdrawn from service with the scaling-down of USN air units and replacement by F/A-18C/Ds, plus planned procurement of the new F/A-18E/F Super Hornet. As an existing Hornet operator from 1987-91 deliveries of 60 EF-18As and 12 EF-18Bs, the EdA reached agreement with the US government in September to buy 24 ex-USN F/A-18A/B airframes plus spares for about \$300 million, for delivery over a four-year period. These will be withdrawn from AMARC storage, and refurbished while being fitted with new GE F404-400 turbofans.

Fifty-one of these engines, incorporating the latest design and material upgrades, have been ordered by the Spanish government from General Electric at a cost of \$145 million. The first six refurbished ex-USN F/A-18s were scheduled for delivery to Spain by the end of last year, with the

More Phantoms sought

Further Spanish acquisitions of US fighters were planned late last year when Washington was approached for price and availability data of six surplus MDC RF-4C tactical reconnaissance fighters. The last USAF RF-4Cs were being retired before the year end from service with the ANG's 152nd Reconnaissance Group, and Spain was planning to spend around \$50 million through FMS channels to supplement the nine reconnaissance Phantoms (CR.12s) already in EdA service.

C-130 upgrade plans

Delays in progress with the European Future Large Aircraft (FLA) programme have resulted in the Spanish government signing a Pts6.7 billion (\$56 million) four-year upgrade contract with CASA for EdA's 13 Lockheed C-130H Hercules. Updates of their flight control, nav/com and defensive sub-systems will be undertaken in conjunction with Lockheed Martin as main sub-contractor, to extend the useful lives of the EdA C-130s, which include five KC-130H

tanker versions, by up to 10 years or more.

New transport helicopter requirement

Eurocopter's AS 532UL Cougar and Sikorsky's UH-60 Black Hawk are competing for an imminent Spanish army aviation (FAMET) order for 15 transport helicopters. The Cougar offers advantages of commonality, since FAMET has been operating 18 of the original AS 332B1 Super Puma versions since 1988, while 16 more are used by the Spanish air force (EdA). Eurocopter's 100 per cent offset offer includes 40 per cent production of the AS 532 by CASA. Spain's GAMESA aerospace company, on the other hand, is a partner in the new Sikorsky S-92 project and would undertake the local assembly of any UH-60s bought by FAMET.

SWEDEN:

More defence cuts proposed

Five-year defence economies of around 10 per cent proposed by a parliamentary committee for the Swedish armed forces include 25 per cent cuts in SAF fighter squadrons from 16 to 12 by the turn of the century. If approved, this would also result in reductions in planned third-batch JAS 39 Gripen procurement from 160 to 75-110, to follow on from the 140 currently ordered.

Re-engined Saab Sk 60 flies

After a two-month delay through airframe interface problems, the first of 115 of the Swedish air force's 140 or so Saab Sk 60 jet trainers began its flight development from Linkoping on 6 October. The programme was intended to replace the aircraft's original 1,640-lb (7.3-kN) Turbomeca RM9 Aubisque engines by the 25 per cent more economical 1,855-lb (8.25-kN) Williams-Rolls FJ44-1C turbofans. Under the 4 November 1993 contract, Saab Military Aircraft will re-engine the first 10 Sk 60s in its Linkoping factory and undertake all required airframe modifications. The remaining FJ44 installations will be undertaken by the SAF by mid-1998 at its Ljungbyhed technical facility.

Some 245 FJ44 engines are being supplied to Sweden for this SEK1 bil-



A long era finally came to an end at Amendola on 30 September 1995 when the Italian air force undertook its final flight of an Aeritalia (Fiat) G91. The specially marked 32° Stormo aircraft (MM6363) was the last to land, flown by Ten. Col. Mario Zanchi. Another scheme was painted on the port side.

lion (\$166 million) contract, which includes options to re-engine 20 more Sk 60s. Apart from better fuel economy and 440 lb (200 kg) less weight, the FJ44s will confer improved take-off, climb and single-engined performance, as well as reduced maintenance costs, plus lower noise and emission levels. The re-engined Sk 60s are expected to recover their programme costs during their planned service lives to at least 2010.

TURKEY:

F-4 upgrade doubts

A controversial \$574 million agreement reached between the Turkish government and Israel Aircraft Industries for the upgrade of 54 THK F-4E Phantom fighters was placed in doubt late in 1995 after defence officials in Ankara questioned its cost-effectiveness. The proposed Phantom 2000 upgrade contract had already been challenged by Westinghouse Norden Systems, whose APG-76 fire-control radar had been replaced by an allegedly lower-cost Elta EL/M-2032 system in IAI's selected submission. This also includes a Kaiser/El Op wide-angle HUD and improved avionics, as well as structural reinforcements and other changes. There were then suggestions that the entire requirement might be re-examined, and reopened for more competitive bids.

UNITED KINGDOM:

Jaguar TERPROM contract

Successful flight trials were undertaken at Boscombe Down of BAe Systems & Equipment (BASE) TERPROM/GPWS digital terrain-referenced navigation and ground proximity warning system in an RAF Jaguar strike-fighter. This has resulted in a £3 million production contract for inclusion of this equipment in the UK Defence Ministry's Jaguar '96 upgrade programme. TERPROM uses a terrain database and radar altimeter information in conjunction with onboard navigation inputs to correlate aircraft position with the stored data. It allows high-speed low-level flight without external navigational aids or tell-tale emissions from terrain-following radar systems, plus other functions, including protec-

tive ground and obstacle proximity warning. Continued delays in the Eurofighter programme have also resulted in re-examination of RAF upgrade plans for the Jaguar's twin Rolls-Royce/Turbomeca Adour Mk 104 turbofans, to provide a 25 per cent thrust increase.

Puma upgrade completed

Racal Avionics, in conjunction with Westland, recently completed a £16.5 million Puma Navigation Update (PNU) programme for the RAF's 42 SA-330 Puma HC.Mk 1 assault helicopters. Apart from Westland, Rockwell Collins and Sextant were involved in the Defence Ministry's SR(A) 1017 programme requirements to give the Pumas a night operations capability. New avionics installed by Westland, under Racal as prime contractor, included provision for night-vision goggles as well as a navigation suite with GPS, VOR/ILS, TACAN, and an Electronic Horizontal Situation Indicator (EHSI). Improvements were also made to defensive sub-systems and covert formation lights, in conjunction with a MIL STD 1388 five-year integrated logistic support programme by Racal.

Similar upgrades are being undertaken by Racal and Westland for the Royal Navy's 145 Lynx HMA.Mk 8 frigate-operated helicopters through the MoD's SR(A) 1008 programme, including installation of a new central tactical system, and for its Sea King ASW helicopters. The companies are also teamed to bid for the installation of GPS, INS and thermal imaging equipment in the RAF's Boeing Chinook MLH fleet. This is being augmented by a September \$365 million MoD contract with Boeing for the 14 extra Chinook HC.Mk 2 helicopters selected with the RAF's EH101s.

100 Sqn moves

Hunting Aviation Ltd, based at East Midlands Airport, has been awarded a

One of the 13 CH-47Ds ordered by the KLu undertakes a test flight from Boeing's Philadelphia plant. The order consists of seven rebuilt aircraft and six new-build machines.



Forty-five SIAI-Marchetti S.208/Ms were procured by the AMI in 1967 as a general purpose utility aircraft. Most now serve as 'hacks' with the Squadriglie Collegamenti assigned to various front-line units. This aircraft wears the Cavallino rampante badge of 4° Stormo (F-104S).

three-year contract to provide engineering support for the 18 BAe Hawks of the RAF's No. 100 (target facilities) Squadron. This unit moved from RAF Finningley to Leeming on 23 September, and continues to provide radar and towed banner target facilities for RAF and NATO forces, as well as training forward air controllers to direct ground attack aircraft in close support.

RN Tomahawks quantified

Pentagon FMS notifications to Congress indicate that Royal Navy procurement of submarine-launched conventionally-armed BGM-109 Tomahawk cruise missiles will initially involve 65 Block 3 versions costing about \$143 million. The Pentagon said the UK's new stand-off long-range Tomahawk capability would enhance Britain's effectiveness in NATO.

Short-range air defence expansion

A £37 million British army follow-on order for Starstreak high-velocity air defence missiles was announced by Shorts Missile Systems in October during formal acceptance of the new weapons system by UK forces in Germany. This involved the self-propelled high-velocity missile system (SP HVM)

mounted on the Alvis Stormer.

Other Starstreak variants under current development include an air-to-air version evaluated for the Army Air Corp's AH-64D Longbow Apache attack helicopters, and a naval ship defence system. BAe Dynamics has received a £100+ million contract for additional radar trackers to meet UK armed forces requirements for all Rapier 2000 SAM units to have Blindfire capability.

UKRAINE:

Bomber return to Russia agreed

Agreement has again been reported between Russia and Ukraine for the repurchase for VVS operation of 19 Tupolev Tu-160 'Blackjack' Mach 2 variable-geometry and 25 Tu-95MS 'Bear-H' four-turboprop nuclear bombers, together with 32 unspecified nuclear missiles. These weapon systems were based in Ukraine – the bombers at Priluki – at the time of the break-up of the former Soviet Union, and prolonged negotiations for their return to Russia had previously been unsuccessful. Most of these aircraft have not remained airworthy because of spares, personnel and technical support problems, and it remains to be seen whether this latest transaction will be satisfactorily concluded.





Under flight test is the Fokker 60 Utility, seen here on its maiden flight on 2 November 1995. Compared to the Fokker 50, the 60 Utility features a stretched fuselage, strengthened cabin floor, large cargo door and quick change passenger/aeromed/cargo interior.

Middle East

ABU DHABI:

VIP King Airs purchased

Raytheon has announced orders from the Abu Dhabi-based UAE Amiri Flight for two VIP-configured Beech King Air 350 light turboprop twins, for early delivery. Although civil-registered, the Amiri Flight aircraft are operated by the UAE air forces and include Airbus A300s, Boeing 737s and 747s, Dassault Falcon 900s, Gulfstream GIIIs and GIVs, and other types.

ISRAEL:

More F-15Is ordered

McDonnell Douglas revealed at 1995's Dubai air show that Israel had taken up an option for another four F-15I multi-role fighters, for 1997-98 delivery. This option was included in Israel's \$1.8 billion F-15I order placed in May 1994, and increases total IDF/AF procurement of this type to 24. These are in addition to earlier IDF/AF deliveries of 52 F-15A/B/C/D versions of the MDC Eagle.

Cobra re-engine programme

The Mata helicopter division of Israel Aircraft Industries has been awarded a contract to replace the Avco Lycoming T53 turboshafts of the IDF/AF's 40 or so Bell AH-1G/S Cobra attack helicopters with uprated and more fuel-efficient GE T700 engines for improved performance. Commonality will also be achieved with the powerplants of the IDF/AF's MDH AH-64A and Sikorsky UH-60 helicopters.

JORDAN:

F-16 acquisition discussed

Post-Gulf War improvements in diplomatic relations with the US following Jordan's October 1994 peace treaty with Israel have resulted in the resumption of military aid to the Amman government. This began with delivery of 18 surplus Bell UH-1H Iroquois utility helicopters to No. 8

Sqn of the RJAF from December 1994. A \$130 million US military aid package for Jordan (awaiting Congressional approval late in 1995) would be insufficient to meet RJAF requests for an initial batch of 24 ex-USAF F-16A/Bs, especially as these would require a 'Falcon Up' upgrade in the US before delivery. US approval is nevertheless expected for this request, as well as for upgrades to Jordan's Hawk SAM systems, plus a follow-on batch of 24 more F-16s at a later stage to equip a second RJAF fighter squadron.

KUWAIT:

UH-60L contract delay

Congressional objections to Special Forces equipment, including laser designators, to be fitted to 16 Sikorsky UH-60Ls in attack configuration requested by Kuwait delayed completion of the proposed \$461 million contract towards the end of 1995. Other items requested included 500 Hellfire ATMs and 38 launchers, plus additional weapons and spares.

OMAN:

More Mushshaks

Four more MFI-17 Mushshak primary trainers have been sold by the Pakistan Aeronautical Complex at Kamra to the Royal Air Force of Oman. These will supplement three earlier examples presented to the RAFO by Pakistan in late 1994.

SAUDI ARABIA:

New combat aircraft deliveries begin

British Aerospace was due to start delivery late in 1995 to the RSAF of the first of its 48 additional Tornado IDS aircraft ordered through the Al Yamamah II contract. Only 96 RB.199 turbofans have been ordered for the RSAF Tornado IDS follow-up contract, which doubles its original inventory of this type, indicating that it already has sufficient stocks of spare

powerplants. Over 2,400 RB.199s have now been produced by the Rolls-Royce/MTU/Fiat Avio partners in Turbo Union, and have accumulated more than three million flying hours. The RSAF will receive all its second-batch Tornados by the end of 1997.

Primary trainer requirement

Increased training requirements by the RSAF to man its new combat equipment include the planned acquisition of about 20 light aircraft for primary

instruction. Evaluations are currently being made by the RSAF of such aircraft as Pakistan's PAC MFI-17 Mushshak and the Slingsby T.67M Firefly.

Saudi F-15S

The first of 72 McDonnell F-15S Eagle fighters for Saudi Arabia was rolled out at St Louis on 12 September 1995. The roll-out ceremony followed a 19 June 1995 first flight. The Royal Saudi air force formally accepted the aircraft the same day. These had been ordered in mid-1993. Deliveries are continuing at the rate of one per month, and accompanying weapons and equipment include Martin Marietta LANTIRN and Sharpshooter navigation and targeting pods, plus 550 of their associated precision-guided bombs.

Far East

CHINA:

F-10 details revealed

Details recently revealed by the US Central Intelligence Agency from satellite surveillance of China's Chengdu F-10 indigenous advanced multi-role fighter, which is being developed with Israeli and Russian industrial assistance, indicate a close relationship with IAI's long-cancelled Lavi combat aircraft. The F-10 employs the same tailless delta layout with large close-coupled canards and a similarly-situated ventral intake. Its single powerplant, however, is reported to be a 27,557-lb (122.58-kN) Saturn/Lyul'ka AL-31F turbofan, as fitted to the Sukhoi Su-27, compared with the Lavi's less powerful Pratt & Whitney PW1120. Russia is also offering a development of the Phazotron Zhuk PH radar, as used in the Su-30 and Su-35, as well as the upgraded F-8 IIM, together with other avionics for the F-10. Pentagon international security chief Joseph Nye said that the F-10, which will make its first flight early in 1996, was expected to become operational around the turn of the century. F-10 performance may be expected to be similar to the 42,500-lb (19,277-kg) fly-by-wire Lavi.

INDONESIA:

ADAF Buffalo transports acquired

Five DHC-5D Buffalo STOL tactical

transports formerly operated by the Abu Dhabi air force have been sold to Indonesia. The TNI/AU was due to take delivery of these aircraft in February and March 1996 after local refurbishment by IPTN.

JAPAN:

FY96 aircraft procurement plans

From original requirements for 81 new aircraft (comprising 42 for the JASDF, 26 for the JGSDF and 13 for the JMSDF) the Japanese Defence Agency has substantially scaled down its purchasing plans for the coming year in the face of FY96 military budget economies for the Self-Defence Forces. With a revised budget of Yen 4,860 billion (\$54 billion), about 2.9 per cent more than in the current year, the JDA now proposes to spend the equivalent of \$8,238 billion on arms and equipment in FY96. This will include 65 new aircraft, with initial production funding for the Mitsubishi FS-X multi-role fighter development of the F-16.

The JASDF's FY96 requirements for 31 aircraft are now listed to include the following, with the original requests in brackets, where changed: 12 Mitsubishi FS-X fighters; five two-seat Mitsubishi/MDC F-15DJs; nine (15) Kawasaki T-4 advanced trainers; one (three) Gulfstream U-4 utility transport; three (four) Raytheon U-125A light jet transports for SAR; and one (three) Mitsubishi/Sikorsky UH-60 Black Hawk helicopter.



The Lithuanian air force operates a fleet of An-2s for general transport duties.



Partnering the An-2s are two Let-410s. The peacetime role of the air force is border patrol.



This Lithuanian Mi-8 is fitted out with a luxury interior for VIP transport work.



The most potent aircraft in the LithAF inventory is the L-39 Albatros, used only for training. Four were purchased from the Kazakhstan air force.



Three Mi-8s serve in the assault transport role, this example wearing a unit badge. Most of the Lithuanian air force aircraft are based at Barysai.

JGSDF requirements, totalling 19 (26) helicopters, are now listed as two (seven) Kawasaki/MDH OH-6Ds; 10 Fuji/Bell UH-1J; four (five) M/S UH-60Js; two Kawasaki/Boeing CH-47 Chinooks; and one (two) Fuji/Bell AH-1S Super Cobra helicopter. JMSDF requests for 15 (13) aircraft comprise a Kawasaki/Lockheed UP-3D Orion EW training aircraft; one (none) Shin Meiwa US-1A amphibian; two (none) Fuji T-5 turboprop trainers; plus eight SH-60J ASW Seahawk and three (two) UH-60J SAR helicopters. A Sikorsky MM-53E mine countermeasures helicopter originally requested has been deleted.

Longer-term JMSDF requirements, for inclusion in the next five-year defence plan, could include up to five BAe/McDonnell Douglas two-seat V/STOL Harrier T.Mk 10s. These would be equipped for electronic warfare training, to supplement four similarly-modified Learjet U-36As, and operate from a 5,000-tonne auxiliary aviation support vessel for offshore operations over longer ranges.

FS-X progress

The first of four FS-X flight prototypes began taxiing trials on 14 September at Komaki, and made its initial flight of 40 minutes at Komaki airport, Nagoya, on 9 October, after delays of several weeks because of technical problems. Flown by Mitsubishi test pilot Yoshiyuki Watanabe, the FS-X was due to be joined by a second single-seat prototype in December, followed in 1996 by two two-seat versions for the flight development programme.

The JASDF is planning to buy up to 141, with an average programme unit cost forecast at around \$82 million. Of these, 74 will equip three combat squadrons to replace 77 Mitsubishi F-1s at Misawa and Tsuiki air bases from 1999, plus 21 for an OCU, and

nine for the JASDF's 'Blue Impulse' aerobatic team. Another eight will be operated by the Tactical Fighter Training Group, two will be used for maintenance training, and the remainder will be held in rotational reserve for attrition, overhaul and maintenance replacements. FS-X cost escalation could reduce these programme totals by up to 50 per cent.

SDF cut-backs planned

Budget economies planned for the Self-Defence Forces include retirement of 40 of the JASDF's remaining 90 or so Kawasaki/Lockheed T-33 jet trainers, and placement of the others in reserve. Basic and advanced training would then be undertaken by 50 Fuji T-3s, 90 Kawasaki T-4s and 86 Mitsubishi T-2As. The JASDF's front-line force of 120 F-4EJ Phantoms will be cut to about 80 in three squadrons, leaving 190 F-15EJs in seven squadrons as Japan's spearhead interceptor force.

Seventy-four Mitsubishi F-1 attack fighters will be replaced by 141 Mitsubishi FS-X combat aircraft in three close support squadrons. The JMSDF will also withdraw about 20 of its 97 Kawasaki/Lockheed P-3C maritime patrol aircraft, for which four-turbofan Mach 0.85 indigenous replacements weighing up to 155,000 lb (70308 kg) are being sought from Kawasaki for service from 2008. Five P-3Cs are to be converted as UP-3Cs for surveillance roles, equipped with side-looking radar.

KOREA (SOUTH):

Rockwell gains F-4 upgrade contract

A major contract has been awarded by the South Korean government to the recently-formed North American Air-

craft Modification division of Rockwell at Anaheim, CA, for the upgrade of up to 90 or so MDC F-4E Phantoms of the RoKAF. Full details of the RoKAF F-4E upgrade are still awaited, but it will mainly involve avionics and systems, to give some commonality with South Korea's F-16s. Rockwell/NAAM is also offering Northrop F-5E/F upgrades to the RoK and other air forces, and has joined with Canada's Bristol Aerospace in bidding for a Turkish F-5A/B modernisation contract.

MALAYSIA:

More C-130s delivered

Delivery took place last December to the Royal Malaysian air force of a follow-up batch of five Lockheed Martin C-130H Hercules. These supplement earlier RMAF receipts of six C-130Hs, one stretched C-130-30 and three C-130H-MP maritime patrol versions. Following the switch to C-130J output, only four similar aircraft and a civil L-100 are left on the production line. Two of the RMAF's original C-130Hs are being converted as aerial tankers by the installation of twin underwing Flight Refuelling Mk 32B hose and drogue pods, plus additional fuselage fuel tanks. The \$15 million contract is being undertaken in Malaysia by Lockheed Aircraft Services joint-venture Airod company, and will supplement the RMAF's current buddy-pack air refuelling system for its MDC A-4PTM Skyhawks.

Army Aviation formed

Transfers began in March 1995 of 10 RMAF SA-316B Alouette III helicopters to the Malaysian army as a foundation of an Army Aviation Wing. The former RMAF air base at Keluang has been taken over for army air oper-

ations, and RFPs have been invited to supply 12-14 attack helicopters. Bids are currently being evaluated from MDH for the AH-64 Apache against proposals for the Atlas Aviation CSH-2 Rooivalk, including joint development and production, plus the Mil Mi-35 and Mi-28.

SINGAPORE:

Aerial tanker requirement

Replacements are being sought by the RepSAF for its four Lockheed KC-130B and single KC-130H aerial tankers. The selected aircraft would have to be faster than the KC-130s and have underwing probe and drogue pods as well as a fuselage refuelling boom for F-16 support. Evaluations are being made of several submissions, including Airbus A310 and Boeing 767 tanker/transports, an IAI/Bedek Boeing 707 conversion, and a variation of MDC's KDC-10 conversion for the RNAF.

TAIWAN:

French missile interest

Continuing French arms sales to Taiwan, as a follow-on to MICA-armed Mirage 2000-5s, are now reported to include the planned order in December of some 550 MATRA Mistral shoulder-launched infantry SAMs. These will supplement pedestal-mounted and helicopter-launched GD Stingers already in Taiwanese service, although the US has vetoed further supplies of the shoulder-launched version of these infantry SAMs. Taiwan is also evaluating Aérospatiale's upgraded AM39 Block 2 anti-ship missile, one of which was recently launched from an AIDC AT-3 light ground/attack fighter. This aircraft is also reported to have performed six test firings of a locally-produced ASHM.

Military Aviation Review

Between 2 and 13 October 1995
Exercise Co-operative Jaguar was held at Karup AB, Denmark, under NATO's Partnership for Peace banner. Former WarPac participation came from Poland, which sent three MiG-23MFs and one MiG-23UB (illustrated) from the 28th PLM at Slupsk.

Last C-130Hs sought

Negotiations were reported late in 1995 with Lockheed Martin for the RoCAF acquisition of the last four C-130Hs off the Marietta production line before the switch to C-130Js. The four new Hercules, which are stretched C-130H-30 versions, would supplement 24 RoCAF C-130Hs ordered earlier in two batches.

THAILAND:

Harrier pilot training begins

Naval aviation expansion is making further progress with the recent start of training by a dozen or so Thai navy pilots in the US. This will be followed by Harrier V/STOL fighter conversion in Spain, in preparation for the RTN's planned acquisition of seven BAe AV-8A(S) and two two-seat TAV-8A(S) Harriers formerly operated by Spain's naval aviation branch until their replacement by MDC/BAe AV-8Bs. The RTN is acquiring the ex-Spanish Harriers and spares for about \$90 million to operate from the 11,400-tonne ski-ramp-equipped V/STOL-carrier *Chakri Naruebet*. The ship is now nearing completion in Spain's Bazan shipyards and delivery is expected in April 1997. It will also operate the RTN's six recently-ordered Sikorsky S-70



helicopters on ASW/ASV and utility roles, but will be too small for the 14 refurbished A-7E and four two-seat TA-7E Corsair IIs now being delivered to the Thai navy from the US. These aircraft will be shore-based to undertake maritime strike missions from U'Tapao naval air station.

F/A-18 procurement plans

The RTAF has finally selected the MDC F/A-18C/D as its new fighter, to supplement its 18 Lockheed Martin F-16A/B Fighting Falcons, and is seeking approval from the US government to buy an initial batch of eight Hornets. Thailand has made it clear, however, that it wants the AIM-120 AMRAAM active radar-homing medium-range missile to arm its Hornets. If the US is unwilling to release this weapon, it may switch to French or Russian alternative systems, such as the Mirage 2000-5/MICA or MiG-29/AA-12 'Adder'.

This would involve an initial batch of 20 Irkutsk-built aircraft, for which India is seeking a barter deal in preference to \$800 million in special loan financing proposed by Moscow.

First flight of the LCA is not expected before late 1997. The first two GE F404-powered prototypes will be followed by three more, including a two-seat trainer and a naval version, with the indigenous GTX-35VS Kaveri turbofan in the Rs41.88 billion (\$1.214 billion) aircraft and engine R&D and pre-production programme. Further funding will then be sought to produce about 100 LCAs from 220 originally requested to start replacing the IAF's MiG-21s from about 2003.

MiG-29M delivery reports

Reports from Delhi indicate that the 10 'Fulcrums' ordered as attrition replacements from Moscow in December 1994 and delivered to the IAF from MiG-MAPO by the end of 1995 are the most recent MiG-29M (MiG-33 for export) versions, although this seems unlikely. Official Russian development funding for this project was restored only in summer 1995, after a three-year hiatus. In early 1995, MAPO General Director Vladimir Kuzmin said that only a pre-series batch of MiG-29Ms had been built, and no problems would be presented for full-scale production "should orders be placed."

The MiG-29M/MiG-33 incorporates many changes compared with earlier versions, including electronically-signalled (fly-by-wire) flight control systems; revised internal structure to accommodate another 1500 kg (3,300 lb) of fuel; improved wing aerodynamics and bigger stabilators; a new Phazotron N010 Zhuk fire-control radar with a programmable signal processor; Geophysika OLS-M IRST/TV/laser sensor system; multi-function cockpit displays; and Isotov/Chernyshev RD-33K turbofans uprated to 19,400 lb (86.3 kN) with afterburning.

It seems more probable that the IAF deliveries were upgraded MiG-29SMs, similar to those recently acquired by Malaysia, with less radical improvements. These include the Phazotron NO19ME Topaz cassegrain radar of the 'Fulcrum-C', which features a synthetic aperture mode and simultaneous twin-target engagement capability with medium-range radar-guided AAMs, and use with precision-guided air-to-surface weapons. The IAF is implementing an upgrade programme by Hindustan Aeronautics Ltd for its 63 earlier model MiG-29s and seven two-seat MiG-29UB combat trainers, presumably to MiG-29SM standards.

Southern Asia

BANGLADESH:

New air force trainers

In addition to a dozen ex-USAF Cessna T-37B basic jet trainers and eight Czech-built Aero L-39ZA Albatros advanced jet trainers delivered late in 1995, the Bangladesh Air Wing was expecting eight Mil Mi-17 utility helicopters from Kazan production. A third Antonov An-32 twin-turboprop transport was delivered to the BAW from Ukraine earlier in 1995.

INDIA:

LCA progress

India's Aeronautical Development Agency rolled out the first technology demonstrator (TD-1) prototype of its Light Combat Aircraft at HAL's Bangalore factory in November. The Delhi government is continuing to negotiate with Russia for the purchase and licensed production by HAL's Nasik plant of the Sukhoi Su-30MK long-range multi-role combat aircraft.



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Phazotron is also supplying new and advanced Moskit radars with enhanced air-to-sea capabilities to replace the Thomson-CSF Agave systems in the IAF's maritime strike Jaguars operating with No. 6 Sqn. Russian companies are further co-operating with South Africa to develop a joint MiG-21 upgrade programme, using some of the latter country's avionics.

The delivery of Boeing KC-135R tankers to Turkey began in mid-1995. The first aircraft in Turkish colours were loaned by the US Air Force.

Naval Harrier upgrade proposals

British Aerospace is collaborating with Israel Aircraft Industries to develop a low-cost upgrade package for the Indian navy's 20 or so Harrier FRS.Mk 51 V/STOL fighters. This could include an Elta Electronics EL/M 2032 pulse-



High over Oxford in October 1995 is Chipmunk T.Mk 10 WB550 of 6 AEF at RAF Benson, the oldest active RAF aircraft. A major rationalisation is seeing the Air Experience Flights and University Air Squadrons merging.

Doppler radar, integration with BAeD's medium-range ASRAAM missile, and an Elta 8240-based electronics warfare suite, plus cockpit and other improvements. Structural improvements and engine modifications would extend the Harriers' useful lives to about 2010 for a cost of about \$100 million. India is also interested in acquiring ex-USMC TAV-8A Harrier trainers from AMARC storage, and has invited tenders from EER Systems in the US for their upgrade.

PAKISTAN:

Mirage 2000-5 purchase plans

US legislation was being finalised late in 1995 for the return of \$658 million paid by Pakistan for 28 F-16A/B fighters, the delivery of which has been irrevocably vetoed by Congress because of Islamabad's nuclear development policies. Following a recent visit to Islamabad by a French defence procurement delegation, the PAF is now planning the purchase of 24 Mirage 2000-5s to replace the undelivered F-16s, which the US is now offering to Indonesia, the Philippines and Taiwan.

The PAF Mirage package will also include medium-range MATRA MICA active radar-homing AAMs, together with IR-guided MATRA Magic missiles for close combat. ATLAS II laser target-designation pods are also being acquired for delivery of precision-guided munitions. Pakistan has expressed interest in acquiring Sukhoi Su-27 air superiority fighters.

Other US arms released

Resolution of the F-16 situation is expected to clear the way for the release to Pakistan of other hitherto embargoed but less sensitive US military equipment worth \$368 million. This includes three Lockheed P-3C maritime patrol aircraft and associated MDC Harpoon anti-ship missiles, as well as 360 more AIM-9L Sidewinder AAMs, plus AN/ALR-69 and AN/ALQ-131 defensive sub-systems, for the PAF's existing F-16s. Hughes TOW 2 ATMs and C-Nite upgrade kits will give the Pakistan army's 19 Bell AH-1F Cobra helicopters a night attack capability.

Spanish Mirage interest

Negotiations were reported late in 1995 for the purchase by Pakistan for around \$30 million of 22 Mirage IIIEE strike/interceptors withdrawn from EdA service in 1991. These would be refurbished and upgraded in a similar manner to some of the 50 Mirage IIIOs bought by Pakistan from Australia. The proceeds from their sale were used by Spain towards a French upgrade of EdA's 55 or so remaining Mirage F1s.

K-8 jet trainer reordered

Evaluation since 21 September by the Pakistan air force at its Risalpur air academy of six jointly-developed AlliedSignal TFE731-2A-engined Nanchang K-8 turbofan trainers has been followed by a follow-up order for a second batch of six aircraft from China. Delivery of these is expected to start in 1997, to begin replacing the PAF's ageing Cessna T-37 basic jet trainers. China's air force of the People's Liberation Army is also expecting its first K-8s within the next few weeks, from an initial production batch of 22-25 aircraft.

SRI LANKA:

Kfir procurement plans

US government approval has reportedly been given for negotiations between Sri Lanka and Israel for the acquisition of eight GE J79-engined IAI Kfir C-2 multi-role fighters from IDF/AF surplus stocks. SLAF combat equipment has hitherto been confined mainly to four Chengdu F-7 versions of the MiG-21, a single two-seat Guizhou FT-7 combat trainer, and two Shenyang FT-5 advanced trainer conversions of the MiG-17 from China. Another six F-7s are reportedly on order. Four FMA IA-58 Pucará twin-turboprop light ground-attack aircraft were also delivered from Argentina in late 1992, but SLAF aircraft attrition has been heavy because of combat and accident losses.

Second An-32 lost

For the second time within a couple of months, the Sri Lankan air force lost



Some of the first BAe Bulldogs to join an RAF Air Experience Flight were those of 9 AEF at Finningley. The 9 AEF/Yorkshire UAS unit has since moved to Church Fenton.

an Antonov An-32 twin-turboprop transport. It crashed into the Indian Ocean on 22 November, killing 54 troops, five airmen and three crew members on board. This accident, off the Jaffna Peninsula, appeared to be a repetition of an SLAF An-32 crash shortly after take-off from Colombo on 13 September, in which all 75 occupants were killed. Three An-32s were bought by the Sri Lankan government from Ukraine in July 1995 for a total of \$13.5 million, to replace two SLAF British Aerospace 748 shot

down in April by Tamil Tiger rebel SA-7 SAMs, with the loss of 97 lives.

The Antonov An-32 losses were not attributed to rebel action, and the fact that these 50-seat aircraft were carrying substantially more passengers could point to overloading as a possible contributory cause. The most recent An-32 accident was the second Sri Lankan Air Force aircraft to have been lost in a week, and the sixth in the past seven months, although some of these may have resulted from Tamil guerrilla action.

Africa

NAMIBIA:

Equipment deliveries

The emergent Namibian Air Wing has recently acquired a Learjet 36 and a Dassault Falcon 900 for use by government officials. This follows a late 1994 contract worth \$5.5 million with India's Hindustan Aeronautics Ltd for two licence-built Aérospatiale SA-315B Lama and two SA-316B Chetak utility helicopters, and deliveries of six ex-USAF Cessna O-2A light tandem-twins.

SOUTH AFRICA:

SAAF aircraft requirements

Negotiations are being finalised with the US by the South African government for the supply through FMS funding of four surplus Lockheed Hercules transports from AMARC storage

for SAAF operation. Three of these would be ex-US Navy C-130F versions, and the fourth would be a similar former USAF C-130B.

Other SAAF aircraft requirements have been stated as 40 to 50 lead-in fighter trainer/light combat types as MB-326 Impala replacements, and a similar number of light twin-turboshaft utility helicopters to replace the current Alouette IIIs. Retirement of the last North American T-6 piston-engined trainer on 17 November marked the end of 55 years of SAAF Harvard service. About 60 Harvards were being offered for disposal late in 1995, following their replacement by a similar number of Pilatus PC-7 Mk 2s, known as the Astra in SAAF service.

TUNISIA:

L-59s delivered

Aero Vodochody delivered all 12 L-59F jet trainers on order to the Tunisian air force from 6 September 1995, as a follow-on to earlier receipts of three Czech Let L-410 twin-turboprop transports.

South America

ARGENTINA:

New aircraft for navy

The Argentine navy received a batch of Grumman Trackers directly from the US Navy, intended to complete the strength of its anti-submarine squadron. Although the transfer involves only a small number of air-

craft, it is significant in that it represents the first delivery of aircraft from the US since 1982. On 19 October 1995, Argentine naval aviation received two Grumman S-2G Trackers, which were moved from Base Naval Puerto Belgrano to Base Aeronaval Comandante Espora. A third complete airframe is expected by mid-November. After their reception



No. 31 Sqn from the Bruggen Strike Wing celebrated its 80th birthday in fine style with this special scheme on one of its Tornado GR.Mk 1s.

the Trackers were stored at Taller Aeronaval Central-TAC (near Cdte Espora) and the best two will be selected for conversion to Turbo Trackers.

The Escuadrilla Aeronaval Antisubmarina currently based at Cdte Espora operates five of the six originally delivered S-2E Trackers. The other aircraft was lost in a fatal crash on 26 November 1990. The upgrade programme for the Tracker continues as planned, with the first Argentine conversion (2-AS-24) making its maiden flight on 3 October. Another two S-2Es are in the process of being re-engined, leaving only one Tracker flying with radials. When the project is finished by late 1996, the Escuadrilla Aeronaval Antisubmarina's complement will include five S-2Es and two upgraded S-2Gs.

The Tracker deal is opening the door for major deliveries of other aircraft to Argentine naval aviation. It is expected that the next transfer will involve helicopters and maritime patrol aircraft. Under consideration is the purchase of up to 12 Sikorsky SH-3H Sea Kings plus a suitable amount of spare parts, being offered by the US Navy. Five SH-3Ds plus two ASH-3H Sea Kings currently are in service with 2 Escuadrilla Aeronaval de Helicópteros. The piece of equipment most urgently needed by the Comando de Aviación Naval is a maritime patrol plane, ideally in the form of six Lockheed P-3B Orions.

During the week from 21 October 1995, the Argentine navy's modified L-188MP Electras performed joint

manoeuvres with P-3 Orions from USN VP-16 'Eagles' and from Canadian Forces VP-407 Squadron.

Marines get their own wings

The Comando de la Infantería de Marina (Argentine Marines), which is considered to be Argentina's best infantry force, is slated to receive its first helicopters. After considering several options, among them the transfer of naval aviation's SA 316 Alouette III, the Marines purchased an initial batch of eight surplus Bell UH-1H Hueys from the US. These helicopters will be assigned to a helicopter battalion that will probably be based at BNIM Baterias, home of the Comando Naval Anfibio, although the deployment of detachments to Marine battalions at Rio Grande and Rio Gallegos is also under consideration. It is not clear whether the Marines will be allowed to operate from ships during amphibious landings. In any event, the Infantería de Marina has become the first force of its kind in South America to operate its own aircraft.

VENEZUELA:

Russian helicopters acquired

The Venezuelan armed forces are acquiring their first Russian aircraft equipment, in the form of 18 Mil Mi-8 and Mi-17 medium-lift utility helicopters. These were formerly operated by the Soviet forces and are being refurbished, with some new equipment and avionics, in Poland.

installation of ECM equipment for the CAF's 30 C-130H Hercules transport/tankers. Two of these have already been fitted with electronic warfare self-protection suites, of which another 28 have now been ordered. Six CAF C-130s have also been equipped with forward (chaff/flare) dispenser kits, with 24 more now on order.

UNITED STATES:

F/A-18E/F Super Hornet flies

A new lease of life for the McDonnell Douglas Hornet, following production of 1,280 earlier versions to date, is forecast following the first flight of the new F/A-18E/F Super Hornet strike-fighter prototype at St Louis on 29 November. The prototype was rolled out on 18 September 1995, allegedly on time, within budget, and weighing 1,000 lb (454 kg) less than its specified limit. Chief of Naval Operations Admiral Jeremy Boorda has said that the F/A-18E/F would be the backbone of the USN well into the future. Seven flight trial and three ground test prototypes planned in the \$3.1 billion R&D programme will be followed by 1,000 or more production Super Hornets for the USN by 2015. Sea trials are scheduled to begin in January 1997, with an initial operational capability in 2001.

Powered by two 22,000-lb (97.86-kN) General Electric F414-GE-400 turbofans delivering 35 per cent more thrust than the Hornet's F404-GE-402s, the Super Hornet has 25 per cent more wing area, 33 per cent more fuel, and a maximum take-off weight of 66,000 lb (29937 kg) instead of 51,900 lb (23541 kg). It also has two more weapons stations, or 11 in all, plus an internal 20-mm M61A1 revolver cannon, for a maximum warload of 17,750 lb (8051 kg). Intake reshaping, new materials and other detailed design changes for low observability will reduce the Super Hornet's radar cross-section to below that of the smaller Hornet.

The aircraft retains the same upgraded Hughes APG-73 radar of the earlier Hornets among its 90 per cent avionics' commonality, but will add a planned integrated defensive electronics countermeasures system, including AN/ALE-50 towed decoys, when a contractor from four competing US teams has been selected for this programme. MDC and Northrop Grum-

man are proposing a dedicated electronic warfare version of the Super Hornet, designated the F/A-18C^W (command and control warfare).

Harrier II debut

The F/A-18E's first flight somewhat overshadowed a similar St Louis debut on the same day of the first of 73 USMC Harrier II V/STOL fighter remanufactured to AV-8B Plus standard. This has APG-65 radar in a new forward fuselage, a Rolls-Royce F402-408 turbofan, and full night attack capability.

KC-135 hose/drogue prototype contract

A long-term requirement to give the USAF's boom-equipped Boeing KC-135 aerial tankers multi-point air refuelling capabilities by the addition of wingtip hose and drogue pods has been revived through a \$24.4 million contract to Boeing Defense & Space Group's Product Support Division in Wichita. This engineering and manufacturing development contract covers the acquisition of two Cobham Group's Flight Refuelling Mk 32B hose-drum pods for a wingtip test installation below one of the USAF's 516 operational KC-135R tankers.

If flight trials prove successful, a \$177 million production contract could follow to equip 33 KC-135Rs with similar installations, allowing them to refuel two probe-equipped USN or NATO aircraft, or a single USAF type with a boom receptacle. Options would also be included to equip another 63 USAF KC-135Rs with similar multi-point refuelling systems (MPRS). The USAF's 57 MDC KC-10 tankers already have both boom and fuselage-stowed drogue-reel systems, although with only a single aircraft refuelling capability.

Other USAF KC-135 upgrade contracts include an initial \$35 million order to a Rockwell Collins team for new glass-cockpit avionics, comprising an FMS-800 flight management system, EFIS-90 flight displays, and WXR-700 weather radar. Options could result in similar installations for the USAF's entire KC-135 fleet, for an overall cost of \$250 million. Programmed Depot Maintenance of the KC-135s is to continue for the second year of a seven-year contract with Pemco Aeroplex.

North America

CANADA:

Civilianised training plans

Procurement is planned by Canada's Bombardier group of up to 35 each EMBRAER EMB-312H Super Tucano basic turboprop trainers and BAe Hawk 100 lead-in fighter trainers if the company's submission for the government's planned privatised NATO Flying Training in Canada programme is accepted. An all-inclusive military training package would then be offered to NATO customers on a commercial basis.

C-130 ECM upgrade

A 15-month \$C13.5 million (\$10 million) follow-on contract from the Canadian Armed Forces has been awarded to CAE Aviation at Edmonton, Alberta, for the manufacture and

With Mitsubishi test pilot Yoshiyuki Watanabe at the controls, the FS-X fighter made its first flight from Nagoya airport on 7 October 1995. After initial manufacturer's trials the aircraft will transfer to the TRDI (Technical Research and Development Institute) at Gifu in early 1996.



USMC Bell AH-1W/ UH-1N upgrade plans

Bell Helicopter Textron is in line for sole-source engineering and manufacturing contracts worth over \$3 billion from the US Marine Corps for major upgrades of the USMC's Bell AH-1W and UH-1N attack and utility helicopter fleets. Both types are to have their service lives extended through at least 2020 though parallel four-bladed rotor (4BW/4BN) and revised cockpit avionics installation programmes, in preference to new aircraft procurement. Some 180 AH-1Ws and 100 UH-1Ns are planned to be upgraded, the latter also being re-engined with GE T700 turboshafts. Flight-development of the upgrades to both types is expected to start in FY2000.

US Navy's 'Krypton' factor

A \$4.7 million USN contract received by McDonnell Douglas marks the first overt acquisition of a contemporary Russian weapon system by the US government. It involves the joint modification with Russia's Zvezda group of the latter's Kh-31 (AS-17 'Krypton') advanced active radar-homing supersonic sea-skimming anti-ship missile as a target drone for tests of the Aegis shipboard air defence system. Four of the rocket-boosted Soyez/Turayev ramjet-powered Kh-31s are being initially acquired by the USN from Zvezda through the US Foreign Comparative Test Program, although options are included in MDC's contract for up to 20. In its original form, the Kh-31 can reach speeds of up to 3600 km/h (2237 mph) over surface-launch ranges of 50-70 km (31-44 miles). Tests of MDC's modified MA-31 target drone version are expected to start this summer.

US Army C-12Rs

Raytheon announced on 28 August 1995 a follow-on contract for acquisition by the US Army of 12 C-12R utility aircraft to be delivered to the Army Reserve between July 1996 and August 1997.

Shown wearing markings for the 27th Fighter Wing commander, this is one of the 54 F-16C Block 30s which are arriving at Cannon AFB to replace the F-111F fleet.

After delivery by sea from AMARC, ex-US Navy Grumman S-2 Trackers are towed to the Argentine navy's Bahia Blanca facility. Here they will be reworked and re-engined as S-2UPs for CANA service with 2 Escuadra Aeronaval.

Cessna OT-47Bs

Cessna has been awarded a Pentagon contract to supply the US Air Force with five OT-47B Trackers, based on the Citation business jet with APG-66 radar and WF-360TL imaging systems.

RF-4C retirement

The 152nd Fighter Group, Nevada Air National Guard, based at Cannon International Airport, Reno, Nevada retired its last four RF-4C Phantom II reconnaissance aircraft on 27 September 1995. The unit is scheduled to convert to the C-130 Hercules.

US Air Force changes

Forthcoming changes in the US Air Force structure include:

- F-4G Phantom Advanced 'Wild Weasels' of the 190th Fighter Squadron, Idaho Air National Guard were being retired from service in October 1995 following a deployment to Incirlik, Turkey. The squadron is converting to A-10s and C-130s. The C-130s will have a firefighting mission.

- Twelve KC-135 Stratotankers of the 43rd Air Refueling Group to move from Malmstrom AFB, Montana to MacDill AFB, Florida.

- The last Douglas KC-10 Extender assigned to Seymour Johnson AFB, North Carolina departed in mid-October 1995 to be reassigned to McGuire AFB, New Jersey, completing the process of enabling Seymour's F-15E-equipped 4th Wing to revert to its former status as the 4th Fighter Wing. As a result of the move, the Air Force Reserve's 916th Air Refueling Wing at Seymour converted to the Boeing KC-135R Stratotanker beginning on 14 October 1995.

Right: During the summer of 1995 this large-scale model of the Lockheed Martin/Boeing X-32 JAST competitor was tested in special rigs at NASA Ames. The model incorporated a fully operating propulsion system, including the novel lift fan proposed for the full-size aircraft.



Last KC-135Q

The US Air Force's last Boeing KC-135Q Stratotanker (58-0099) departed the 98th Air Refueling Squadron at Fairchild AFB, Washington on 29 September 1995 and is to be converted to KC-135T standard. At one time, the USAF had 56 KC-135Qs (counting at least two lost in mishaps), powered by Pratt & Whitney J57-P-9 turbojet engines and identical to the KC-135A except that the Q model was designed to isolate two separate fuel types within its fuel cells. This design gave the KC-135Q the distinction of being the only aircraft capable of refuelling the Lockheed SR-71 Blackbird, which uses a fuel different from other USAF aircraft (JP-7 fuel for its J58 engines rather than the JP-5 and JP-8 in widespread use elsewhere). KC-135A/Q tankers are associated with the huge clouds of black smoke generated by water-injected J57 engines, while KC-

135R/T models use cleaner, more powerful F108-CF-100 (CFM-56) engines.

F-111 retirement

The US Air Force has begun retiring its General Dynamics F-111 'Aardvarks', all of which belong to the 27th Fighter Wing at Cannon AFB, New Mexico. Except for the EF-111A electronic warfare aircraft which will remain for a slightly longer time, all are to be removed from service by 30 September 1996. First to go are the F-111Es which equip one squadron in the wing (428th FS), to be followed by F-111F models equipping three squadrons (522nd, 523rd, 534th FS). Although the F-16C Fighting Falcon is replacing the 'Vark' in the 27th FW, the USAF considers the replacement for the F-111 in the deep strike mission to be the McDonnell F-15E





Strike Eagle, which equips fighter wings in North Carolina and England, and composite wings in Idaho and Alaska.

The first F-111s to be pulled out of service headed for the 'boneyard' on 11 October 1995. Six F-111Es from the 428th Fighter Squadron left for the Aerospace Maintenance and Regeneration Center at Davis-Monthan AFB, Arizona. The action comes nearly 31 years after the F-111 made its maiden flight on 21 December 1964. Once called 'McNamara's Flying Edsel', in reference to former Secretary of Defense Robert C. McNamara, and the ill-fated automobile of the 1950s, the F-111 overcame a prolonged and problem-plagued gestation to be recognised as one of the most effective all-weather interdiction aircraft in the world. Within the USAF, some argue that it is being replaced prematurely as one of many measures undertaken to preserve funds for the USAF's top priority, the Lockheed Martin F-22 advanced tactical fighter. Once the transition is complete, 54 F-16Cs will be assigned to Cannon AFB.

EF-111 respite

The US Air Force has changed a plan to retire its EF-111A 'Spark Vark' electronic warfare fleet by the end of September 1996. The USAF now plans to operate its current force of 24 EF-111As until then, and to keep 12 in service until late 1998. By that time, the US Navy's EA-6B Prowler – its



own numbers stretched thin – will take over the EF-111A's duties.

Last active-duty F-15B departs Tyndall

The 95th Fighter Squadron's last F-15B, tail no. 77-0156, departed Tyndall AFB, Florida on 22 September 1995 en route to becoming a permanent maintenance trainer for new crew chiefs. It was the last active B-model F-15 in the Air Force inventory.

C-130 developments

Lockheed Martin rolled out the first C-130J Hercules for the Royal Air Force in October 1995 and followed with the first C-130J for the US Air Force two days later. First off the production line was the stretched C-130J-25, the first of 25 aircraft for Britain. Deliveries to the RAF were scheduled to begin at the end of 1996 after a 12-month flight test programme. The first of two C-130Js for the USAF is a standard-length Hercules. The manufacturer claims that the C-130J's take-off distance is 32 per cent less than the older model, it can climb 24 per cent more quickly, cruise 16 per cent higher and 5 per cent faster, carry the same payload 46 per cent farther, and land in 6 per cent less distance.

Meanwhile, the first production Hercules, AC-130 53-3129, nicknamed 'First Lady', made its final operational flight on 10 September 1995

The 'Louisiana air force' – a B-52H and A-10A from the Barksdale-based 917th Wing are joined by an F-16C from the New Orleans-based 926th FW. All the aircraft are flown by Reserve units, highlighting the importance of reservist units in the overall Air Force organisation. The 926th is scheduled to revert to its former mount (the A-10) shortly to help the AFRes organisation comply with new directives that it should only operate the equivalent of one wing of fighters.

and has now been retired by the Air Force Reserve's 711th Special Operations Squadron, 919th Special Operations Wing at Duke Field, Florida, after 40 years and 13,600 flying hours. The 919th SOW has started to convert to the MC-130E Combat Talon I and the HC-130 Combat Shadow.

Lockheed Martin is modifying 29 C-130E and C-130H transports to carry the AN/ALQ-131 self-protection jammer for operations over Bosnia-Herzegovina. Previously, this electronic countermeasures pod was carried only by fighters.

Ten AC-130H and 13 AC-130U Spectre gunships operated by the USAF's Special Operations Command are being upgraded by Texas Instruments' Defense Systems & Electronics Group in Dallas. This is supplying second-generation FLIR systems through a contract worth more than \$50 million.

B-52 developments

The Boeing B-52 Stratofortress is the longest-serving warplane in the history of aviation, but the US Air Force is now planning to remove 28 of its 94 remaining B-52Hs from service by September 1996. Once the move is completed, the USAF will be on the way toward its force structure goal of 66 B-52Hs, 95 Rockwell B-1B Lancers, and 20 Northrop B-2 Spirit 'Stealth Bombers' (although only six of the B-2s are in service now and aircraft no. 20 will not be delivered until January 2003).

At the beginning of 1995 the 5th Bomb Wing at Minot AFB, North Dakota activated the 72nd Bomb Squadron as its second B-52H unit to operate alongside the 23rd BS. The new unit received its full complement of aircraft transferred from the 410th and 416th Bomb Wings, with more than 30 Stratofortresses now located at

A new Eagle operator is the 159th Fighter Squadron, 125th Fighter Group of the Florida ANG. Shown is the 'boss bird' with fin lightning bolt, 'Florida' in script across the fin tip and the badge of the local Jacksonville Jaguars football team on the nose. The 'FL' tailcode has been dropped. In addition to their operations from Jacksonville, the unit maintains a four-ship detachment at Tyndall AFB, and is shortly to reinstate an alert detachment at Homestead AFB. The current detachment at NAS Key West will be discontinued when the unit completes its conversion from the F-16ADF.

Minot. However, after just seven months the squadron has been identified for inactivation with some of its aircraft scheduled for retirement to AMARC for storage. Funding for operations was allocated for FY 1995 for both squadrons, but only partially financed for FY 1996 which enabled only the 23rd BS to remain fully operational. The 72nd BS is due to see six B-52Hs retired between January and March 1996, with the remaining six following between April and June prior to the squadron inactivating.

The 2nd BW at Barksdale AFB, Louisiana is also to lose some of its B-52Hs, with four due to be retired early in 1996. The wing will gain the appropriate B-52 functions of the tactics and training courses which have been performed by the 99th Wing at Ellsworth AFB, South Dakota at the LeMay Center. The move will centralise B-52 training at Barksdale AFB.

Proponents of a longer life for the B-52H argue that it is alone among the three current bombers in being able to carry the AGM-86B/C Air-Launched Cruise Missile (ALCM) and AGM-129 Advanced Cruise Missile (ACM). Because no large aircraft has ever been returned to service from the 'boneyard' (at Davis-Monthan AFB, Arizona), the service plans to hold the 28 B-52Hs in 'attrition reserve' at Minot AFB, North Dakota.

Meanwhile, in an effort codenamed Long Rifle, a B-52H set a world record from Edwards AFB, California, on 25 August 1995. The crew and aircraft from Barksdale's 2nd Bomb Wing attempted the speed record for flying 10000 km (5,400 nm), unrefuelled, with a payload of 5000 kg (11,000 lb), in an aircraft that weighed between 440,000 and 550,000 lb (200 and 250 tonnes). They set the record in 11 hours, 23 minutes with an average speed of 556 mph (895 km/h). The B-52H Stratofortress crew that launched from Edwards on 25 August was originally scheduled to fly to Greenland but, because of weather conditions, flew to Alaska. The crew then flew into the Precision Impact Range Area near Edwards and dropped 19 dummy 500-lb (227-kg) bombs. An observer from the US National Aeronautics Association was on the flight, representing the Fédération Aéronautique Internationale, the aviation world record sanctioning body.

USAF tankers loaned to Turkey

The US Air Force has loaned the Turkish air force two KC-135R tankers while the five aircraft scheduled for transfer to the Turks are removed from storage and prepared for service. The two aircraft concerned were flown unmarked from Grand Forks AFB, North Dakota on 15 July to RAF Mildenhall, where personnel applied the Turkish flag and national insignia. The two aircraft were delivered to Mürted Air Base on 22 July. The first two aircraft destined for transfer to the Turkish air force were being

prepared for the ferry flight from Davis-Monthan AFB, Arizona after being stored with the Aerospace Maintenance and Regeneration Center (AMARC). The two aircraft were due to be flown to the Boeing facility at Wichita, Kansas where they will be converted from KC-135A configuration to KC-135Rs with the fitment of General Electric/SNECMA F108-CF-100 engines.

US Air Force announces unit changes

The USAF announced a series of unit changes during mid-August, although in reality the majority are a reduction in strength for the Air National Guard and Air Force Reserve. Commencing with the ANG, most of the changes involve 19 F-16 squadrons reducing their complement by three aircraft, although the aircraft will be transferred to other units which are upgrading from the F-16A/B to the F-16C/D models. F-16C/D units which are to see their complements reduced are:

107th FS Selfridge ANGB, Michigan
112th FS Toledo Express Apt, Ohio
113th FS Hulman Apt, Terre Haute, IN
120th FS Buckley ANGB, Colorado
121st FS Andrews AFB, Maryland
124th FS Des Moines IAP, Iowa
125th FS Tulsa IAP, Oklahoma
134th FS Burlington IAP, Vermont
138th FS Hancock Field, Syracuse, NY
149th FS Richmond IAP, Virginia
157th FS McEntire ANGB, SC
160th FS Montgomery, Alabama
162nd FS Springfield-Beckley MAP, OH
163rd FS Fort Wayne IAP, Indiana
170th FS Capital MAP, Springfield, IL
174th FS Gateway Apt, Sioux City, IA
175th FS Joe Foss Fld, Sioux Falls, SD
176th FS Volk Field, Madison, WI
198th FS Muniz ANGB, San Juan, PR

Most of the reductions should have taken place during late 1995. The few remaining F-16A/B squadrons are due to upgrade to the F-16C/D, including the 114th FS at Klamath Falls IAP, Oregon; 178th FS at Hector Field, Fargo, North Dakota; 179th FS at Duluth IAP, Minnesota; 184th FS at Fort Smith MAP, Arkansas; and the 186th FS at Great Falls IAP, Montana. Four of these have the air defence mission as their primary role, but will switch to that of general-purpose fight duties, including interception. These upgrades will be implemented during early to mid-1996 and should see the virtual withdrawal of the F-16A/B model from USAF duty with all but the test organisations. The number of F-16s in store at AMARC is more than 300 at present.

The five ANG A-10A Thunderbolt II units will also be reducing their complement, although this will only be a single OA-10A in each case, with the change due in mid-1996. The Air National Guard had announced that several of its tanker squadrons were to have lost a single KC-135E each during 1995 or 1996. This has since been cancelled for eight of the squadrons involved, with the 133rd ARS at Pease AFB, New Hampshire actually increas-

Serving at the USAICS at Fort Huachuca, Arizona, are a number of Cessna O-2As. These have had propeller spinners refitted.

ing its complement by a single KC-135R in mid-1996. The 196th ARS at March AFB, California began conversion from 10 KC-135Es to nine KC-135Rs during late 1995, with other ANG squadrons due to exchange the E for the R model during the next few years.

The 190th FS at Boise Air Terminal, Idaho began the process of withdrawing the F-4G during September, with two being retired to AMARC in 1995 prior to the withdrawal of the 26 other aircraft early in 1996. The squadron has six F-4Gs at Dhahran AB, Saudi Arabia which were due to be flown home by mid-December. The 190th FS is to receive 17 OA/A-10As from early in 1996, with the 189th being reactivated as an Airlift Squadron to operate four C-130Hs to perform fire-fighting and general airlift duties with the Idaho ANG.

The Air Force Reserve will implement a small number of alterations, including the 452nd Air Mobility Wing at March AFB, California and the 927th ARW at Selfridge ANGB, Michigan which both reduced their complement by a single KC-135E late in 1995. The 919th SOW at Duke Field, Florida withdrew the last of its AC-130As at a ceremony during late September. The majority were retired to AMARC, although the first production Hercules, AC-130A 53-3129, was subsequently flown to Eglin AFB to be placed on display with the Armament Museum. In place of the Gunships, the 711th SOS has received eight MC-130E 'Combat Talon Is' together with four HC-130N/Ps. The MC-130Es were drawn from the 16th SOW at Hurlburt Field, Florida and the 353rd SOG at Kadena AB, Okinawa which has upgraded to the MC-130H 'Combat Talon II'.

Air Combat Command is in the process of reforming the 6th Reconnaissance Wing at Robins AFB, Georgia prior to the delivery of the first of 17 E-8C J-STARS which will commence early in 1996. The first production E-8C began flight test on 17 August, and will spend a period of evaluation with the prime contractor Northrop Grumman at its Florida facility, as well as the Air Force Flight Test Center at Edwards AFB, California.



At Langley AFB, Virginia the 1st FW should have been reduced in strength by three UH-1Ns during late 1995, while the 71st Rescue Squadron at Patrick AFB, Florida should have gained a single HC-130N also by late 1995. The 1st FW administers the active-duty rescue assets at Patrick AFB. The 20th FW at Shaw AFB, South Carolina will gain an additional six F-16C/Ds during mid-1996. At Cannon AFB, New Mexico the 27th FW began retiring its F-111E and F models to AMARC during September 1995, with a total of 74 aircraft due to be exchanged for 54 F-16C/Ds. The 522nd FS had already received former 35th FW Fighting Falcons from Misawa AB, Japan. Once its complement has been retired, the 428th FS, which has performed the training role, will inactivate. The 27th FW is expected to be fully operational by the spring of 1996, enabling the wing to be the core unit at Green Flag 96-3 at Nellis AFB, Nevada in March and April 1996. The 1st Air Force at Tyndall AFB, Florida, which is responsible for air defence activities within the USA but which does not have any aircraft assigned, will transfer from Air Combat Command to the Air National Guard by mid-1997.

The return to operational service of the SR-71A was due to have seen the first two aircraft flown from Palmdale, California to nearby Edwards AFB in September 1995. However, both were still at Palmdale in October, with January 1996 as the revised delivery date. Once the aircraft have relocated to Edwards AFB, they can then commence operational duties overseas, which is the main reason why the aircraft are being returned to service.

Within Air Mobility Command the 19th ARW at Robins AFB, Georgia will lose eight KC-135Rs from mid-1996. The base is due to see the formation of the 6th RW in 1996, so it is

quite likely the 19th ARW will be downgraded to Group status in accordance with the USAF policy of one base, one wing. Robins AFB is an Air Force Materiel Command facility with both the 6th RW and 19th ARW as tenants. At Fairchild AFB, Washington the 92nd ARW reduced strength by eight KC-135Rs at the end of 1995.

The one sector of the USAF which has largely escaped cuts in recent years has been the Pacific Air Forces. The only change was to the 3rd Wing at Elmendorf AFB, Alaska, which was reduced by one C-12F late in 1995.

Air Education and Training Command recently implemented plans to exchange the Singapore air force training element of eight F-16A/Bs for 11 F-16C/Ds. The F-16A/Bs were formerly with the 'Thunderbirds' display team. The Singaporean aircraft are operated in full USAF markings and are assigned to the 425th FS at Luke AFB, Arizona under the 56th FW. At Altus AFB, Oklahoma the 97th AMW was reduced by three C-141Bs late in 1995, reflecting the gradual rundown in the need for additional StarLifter aircrew as the C-17 continues to enter service with the 437th AW. The 58th SOW at Kirtland AFB, New Mexico gained two HH-60Gs in late 1995, while at the same time losing one MC-130E and an HC-130N.

Air Force Special Operations Command has recently changed the complement of the 16th SOW at Hurlburt Field, Florida. The 20th SOS has added three MH-53Js to give the squadron a complement of 20 helicopters. The 15th SOS was reduced by a single MC-130H at the end of 1995, that aircraft being transferred elsewhere. The 8th SOS will lose four MC-130Es to the 711th SOS at nearby Duke Field by mid-1996. Finally, the 5th SOS will receive the last of its 12 AC-130Us in mid-1996.



NATO aircraft attack Serb targets in Bosnia

NATO began Operation Deliberate Force on 30 August when aircraft from several countries were finally given the go-ahead to attack Serbian positions in Bosnia after three years of provocation.

A collection of aircraft on the arrivals ramp at AMARC/Davis-Monthan AFB is dominated by one of the two NKC-135As operated by the US Navy on electronic warfare training duties. The remaining NKC-135A is still in use, supported by the sole EC-24A.



The first raid involved more than 60 aircraft and was in retaliation for the Serb shelling of Sarajevo's central market on 28 August, when 37 civilians were killed and dozens of others injured. Numerous targets were struck by the NATO fighter-bombers, including surface-to-air missile sites, barracks, ammunition dumps and air defence complex located around Sarajevo as well as elsewhere in Bosnia. By the end of the first day of the operation, more than 200 sorties had been flown against 23 targets. The NATO aircraft were launched from bases in Italy and from the US aircraft carrier CVN-71/USS *Theodore Roosevelt* on station in the Adriatic Sea.

The operation was not confined to a single retaliatory strike as had previously been the case, as the NATO aircraft performed additional attacks throughout the first two weeks of September. The majority of US land-based strike aircraft were operated from Aviano Air Base, Italy. These included the resident 510th and 555th Fighter Squadrons of the 31st FW operating the F-16C/D. The number of aircraft deployed had been increased shortly before operations began, including eight F-16Cs of the 23rd FS, 52nd FW from Spangdahlem AB, Germany which arrived on 14 August to bolster the fighter capability. The 48th FW at Lakenheath had eight F-15Es detached, although surprisingly there were no USAFE F-15C in residence to perform fighter escort or air defence. The 81st FS, 52nd FW had regularly provided A-10As for Operation Deny Flight, although these had been withdrawn to enable the squadron to perform a routine deployment to the USA. In their place was a dozen A-10As of the 131st FS, Massachusetts Air National Guard which had arrived on 16 August. Battlefield management was provided by three EC-130Es of the 41st ACCS, 355th Wing from Davis-Monthan AFB, Arizona which co-ordinated activities and provided updates to the fighter packages once airborne. These were joined by a trio of EC-130H 'Compass Call' communications jammers which arrived at Aviano in mid-August.

Among the types of weapons used were 1,000-lb and 2,000-lb bombs, many of which were laser guided to minimise collateral damage and avoid unnecessary civilian casualties. In addition, AGM-88 High-Speed Anti-Radiation Missiles (HARM) and Air-Launched, Anti-Radar Missiles (ALARM) were fired at selected targets.

Intelligence was provided by RC-135V and W 'Rivet Joint' platforms operating from RAF Mildenhall on a daily basis. In addition, a number of U-2R missions were launched from RAF Fairford to gather updated information on the location and strength of the Bosnian Serb positions around the United Nations safe areas. These two aircraft types had performed such missions on a regular basis during Operation Deny Flight. A U-2R on an intelligence-gathering sortie over Bosnia was destroyed when it crashed at Fairford while returning to the base on 29 August with a technical problem. Sadly, despite ejecting from the aircraft the pilot was killed. The aircraft was fitted with the Senior Span data link relay system. The crash was untimely as it happened on the day before NATO began its air offensive against the Serbs.

The US Navy had four EA-6Bs of VAQ-141 from Carrier Air Wing 8 (CVW-8), normally embarked aboard *Theodore Roosevelt*, deployed to Aviano. These were joined by a similar number of Prowlers from VAQ-130 of CVW-3 aboard CVN-69/USS *Dwight D. Eisenhower*. The US Marine Corps has had an ongoing commitment to support Deny Flight, with eight F/A-18Ds rotating to Aviano from various Stateside-based squadrons. At the time of Deliberate Force, VMFA(AW)-533 was in residence.

Among the units formed into CVW-8 aboard *Roosevelt* were VF-41 with the F-14A, VFA-15, VFA-87 and VMFA-312 all flying the F/A-18C, VAW-124 operating the E-2C, HS-2 flying the SH-60F and HH-60H, VS-24 operating the S-3B, and VQ-6 flying at least one ES-3A. In addition, a detachment from VRC-40 operating a pair of C-2A Greyhounds was in resi-

dence. The assault carrier LHD-3/USS *Kearsarge* was also on station with a mixed complement formed around HMM-263 with the AH-1W, UH-1N, CH-46E, CH-53E and AV-8B.

Special operations aircraft and helicopters were stationed at Brindisi airport in southern Italy, including MH-53Js of the 21st SOS, 352nd SOG from Mildenhall along with MC-130Es of the 8th SOS and AC-130Hs of the 16th SOS, both deployed from the 16th SOW at Hurlburt Field, Florida. An additional pair of MC-130Es was flown to Brindisi from the USA on 31 August, possibly to bolster the rescue effort for the crew of the French air force Mirage 2000N which was shot down near Pale, Bosnia on 30 August.

Air refuelling support played a vital role in extending the range of the strike aircraft, with USAF KC-135Rs operating from Istres AB, France and Pisa AB, Italy. The tankers were drawn from Stateside-based units but placed under the control of the 100th Air Refueling Wing with its headquarters at Mildenhall.

Last Minuteman II ICBM retired

The 351st Missile Wing was inactivated at Whiteman AFB, Missouri on 31 July 1995, bringing to an end the career of the LGM-30F Minuteman II Intercontinental Ballistic Missile. The Minuteman II served as one of the three forms of nuclear deterrence with Strategic Air Command and latterly Air Force Space Command for 30 years, without being fired in anger. The withdrawal from service of the ICBMs was brought about through the Strategic Arms Limitation Treaties agreed between the US and the Russian governments.

Speckled Trout moves home

C-135C 61-2669 – which for many years has been better known by its unofficial nickname *Speckled Trout* – has moved home to Edwards AFB,

A recent addition to the list of USAF tailcodes is 'JZ', applied to the F-15A/Bs of the 122nd FS/Louisiana ANG at New Orleans, the home of jazz. The Guard lost one squadron of F-15s in the autumn of 1995 when the 128th FS/Georgia ANG began its transition to the B-1B.

California. The aircraft was operated by Detachment 1, 4950th Test Wing at Andrews AFB, Maryland, but has since been relocated to Edwards AFB, California and reassigned to the 412th Flight Test Squadron, 412th Test Wing. The aircraft is operated primarily as the carrier of the Air Force Chief of Staff as well as other senior USAF personnel. The aircraft has received a unique modification recently, having been fitted with a 'glass' cockpit containing the latest state-of-the-art flight controls. The refit is being evaluated by the 412th TW, with other selected C-135s likely to be modified at some stage in the future when funding is made available.

Fleet Information Warfare Center established

The Fleet Information Warfare Center (FIWC) was formed by the US Navy at Norfolk, Virginia on 1 October to replace the Fleet Tactical Readiness Group (FTRG). The latter had only been in existence for a short while, recently having been renamed from the Fleet Electronic Warfare Support Group (FEWSG). The organisation has no aircraft of its own, although it has responsibility for the two NKC-135As and the solitary EC-24A which are contracted to Chrysler Technologies at Waco, Texas. The FIWC has inherited only one of the NKC-135As, as 563596 was retired to AMARC in June 1995 after spending nine months in store at Waco awaiting finance for depot-level maintenance, which has not been made available.

Third Marine Air Wing commences helicopter moves

The 3rd Marine Air Wing (3rd MAW) of the US Marine Corps, which is responsible for the front-line assets located on the western side of the United States, has begun the next stage in the process of relocating its aircraft and helicopters. Fixed-wing types began moving from MCAS El Toro, California to NAS Miramar in August 1994, with five squadrons having completed the journey by September 1995. During the autumn of 1995 the first of the helicopter squadrons based at MCAS Tustin began moving to El Toro. The CH-46Es of HMM-166 commenced the move during October 1995, with the remaining dozen or so squadrons due to follow during the coming months. The move is believed to be a temporary measure as El Toro is due to be closed once it is vacated. Once the move of the Marine Corps fixed-wing assets to Miramar is completed and the remaining Navy squadrons have moved elsewhere, the



Tanker units were assigned Beech C-12s to provide low-cost flight hours under the Companion Trainer Program, although most have now been reassigned to the US Army. This aircraft wore the colours of the Malmstrom-based 43rd Air refueling group.

3rd MAW will then evaluate the possibility of centralising the helicopters from El Toro.

The F-14 squadrons remaining at Miramar will eventually be consolidated at NAS Oceana, Virginia, and the Naval Fighter Weapons School ('Top Gun') will move to NAS Fallon, Nevada.

Arizona Air National Guard expands role

The 162nd Fighter Group at Tucson International Airport, Arizona was upgraded to Wing status on 1 October 1995, thereby more accurately reflecting the unit's increasing training role. The wing is responsible for the 148th, 152nd and 195th Fighter Squadrons which are divided in separate A and B flights, as well as the Air National Guard and Air Force Reserve Test Center. The wing has approximately 72 F-16s assigned, although the unit is

currently in a state of flux with aircraft being retired as newer equipment is received. The unit operated the F-16A/B exclusively until 1994, when examples of the C and D model were received. Subsequently, additional F-16C/Ds have arrived, with approximately 20 having been received by October 1995. The F-16A/B versions were from several Block numbers including Blocks 1 and 5 which were part of the first production batch ordered in 1978. In addition, there were several aircraft from Fiscal Year 1979 and 1980 production, including 80-0492 which has been specially marked for the unit commander with '162 FW' on the fin. Of the F-16C/Ds received, most have been from Block 25 production ordered in 1984.

It was announced earlier in the year that the majority of training of overseas F-16 pilots would be conducted by the Air National Guard at Tucson



The US Air Force Academy at Colorado Springs employs a pair of de Havilland Canada UV-18Bs on parachute training duties. Procured during FY 1977, they fly wearing civil registrations.

instead of being performed by the Air Education and Training Command at Luke AFB. To enable students from numerous overseas air arms to receive satisfactory tuition on the equipment they will operate once they graduate, the 162nd FW has started to receive new equipment. Among the newly delivered aircraft are some from FY 1989 and 1990 production which were from Block 42H. Most were formerly with the 57th Wing at Nellis AFB, Nevada before being transferred to the Air National Guard.

Despite reports elsewhere, the wing will retain a number of F-16A/B models and will not convert fully to the F-16C/D, because several overseas customers operate the earlier version of the Fighting Falcon. The wing is currently conducting conversion courses for aircrew from Turkey and the Netherlands, as well as at least one Middle East country. Plans are in hand for other nations' pilots to be trained at Tucson once all the new F-16s are received. The three squadrons are applying tailcode 'AZ' to their aircraft;

the F-16C/D models applied these markings earlier in the year, although the F-16A/B versions were seen with the two-letter identifier applied for the first time in October 1995. Many aircraft have 'IMT' on the fin - indicating International Military Training - as these are dedicated to the training of overseas students.

The ANG/AFRes Test Center has approximately 10 aircraft assigned, including the F-16A and C versions, as well as at least one F-16 Air Defence Fighter. The Center conducts evaluation of various items of equipment and techniques in relation to the reserves, before these become operational with the two organisations.

64-17971 was the first of two Lockheed SR-71As to be revived for operation by the 9th Reconnaissance Wing. Here the aircraft is seen taking off from the Lockheed Martin Skunk Works, where the overhauls have taken place. Note the new serial presentation on the fin. Operational use is expected from December 1995.



Operation Crucerelle

French aircraft operating over Bosnia from bases in Italy have been at the cutting edge of Operation Deny Flight. Their deployment, known as Operation Crucerelle, has included a wide variety of aircraft, using a sometimes unusual combination of equipment and techniques. The French position in Bosnia has been one of aggressive 'peacekeeping', both in the air and on the ground, and its forces have taken the greatest losses. However, France has also been one of the most steadfast participants in UN operations throughout the war-torn former-Yugoslavia.

Changes occurred during 1995 in the deployment of the French aircraft based in Italy participating in Operation Deny Flight over Bosnia. The first change, in spring (end of March, beginning of April), was the departure of the French detachment from Istrana. The Italians closed the base temporarily, to repair Istrana's runway and associated arrester gear. Consequently, the French aircraft moved elsewhere until the completion of repairs in early June.

It was decided not to keep the entire detachment in Italy. As the only true reconnaissance aircraft flown by the French air force in Operation Deny Flight, the 5 Mirage F1CRs of ER 1/33 'Belfort' and ER 2/33 'Savoie' stayed in Italy and moved to Cervia. There they joined up with the air defence Mirage 2000Cs of EC 5 and EC 12, and the close air support Mirage 2000Ns of EC 3 and EC 4.

The Mirage 2000Ns undertake almost the same mission as do the Mirage F1CTs of EC 13



and the Jaguars of EC 7 and EC 11. These three units gave up their tasking to the Mirage 2000Ns, and returned to their home bases, Colmar, Saint-Dizier and Toul, where the crews and aircraft were kept on alert. This status was to be held until June, when they returned to Istrana.

Cervia's Mirage 2000Ns, which had previously been fitted with four 250-kg GP bombs, flew with only two, hung on the forward underfuselage pylons. The Mirage 2000Cs also had their time flying as 'bombers' instead of fighters, carrying two bombs and two 2000-litre (528-Imp gal) wing tanks. The bombs, formerly fitted on the rear underfuselage pylons, caused some balance problems once the internal fuel tanks were empty and they were quickly moved to the forward positions.

Mirage 2000s equipped with the massive 1300-litre wing tanks were restricted to carrying a pair of MATRA Magic 2 missiles.





Today, the Mirage 2000Cs are all back in the fighter role, albeit with a major change in their ordnance load. The former combat air patrols over the Adriatic Sea were initially flown in the standard air-defence configuration of two medium-range radar-guided Super 530 missiles, two self-defence Magic 2 IR missiles and a centreline 1300-litre (343-Imp gal) tank. Later, the Mirage 2000Cs were equipped with the same 2000-litre wing tanks as those usually seen on the Mirage 2000Ds and 2000Ns (some grey-camouflaged 2000Cs flew with green and dark grey tanks borrowed from Mirage 2000Ns). These tanks prevented the use of the Super 530s, so that the only armament left was the two MATRA Magic 2s, making the Mirage 2000Cs a less capable fighter than before.

On occasions when two Magic 2s was the standard equipment for aircraft flying CAP missions over the Adriatic Sea, two other aircraft with a complete ordnance load were kept on alert at Cervia, under shelter. This enabled the Mirage 2000Cs to maintain the ability to fly real CAP missions, should that become necessary.

Missile overhaul

There are both technical and financial reasons for such an arrangement. The Super 530 has a limited number of flight hours and must undergo periodic technical overhauls. Some tests can be made by the operating units, but for major overhauls the missile must be returned to the manufacturer, which costs both time and money. After a number of manufacturer overhauls, the missile must be withdrawn from operational use and kept for live exercises. Therefore, having aircraft flying with only Magic 2 missiles allows the Armée de l'Air to save some money and prolong the operational

lives of its equipment, and to prevent a shortage of Super 530s.

The move from Istrana to Cervia did not have a large impact on missions. It did result in Cervia becoming the most important platform used by the French, and therefore inheriting some tasks formerly assigned to Istrana. Having already been the main source of intelligence reports because of the presence of the F1CRs, Istrana had also periodically been visited by the two C.160Gs of EE 54 'Dunkerque'. Their aircrews could use the facilities of Istrana's F1CR Intelligence Cell for the distribution of intelligence gathered during their flights. These C.160Gs flew ESM missions over the Adriatic Sea directly from Metz on an almost weekly basis, and systematically spent one or two days each month in Italy, which is closer to the C.160Gs' area of responsibility. When the Istrana-based detachment moved to Cervia, the

This Mirage 2000N of EC 2/4 wears the flying stork badge of SPA 167 on its tail and is carrying a pair of 250-kg bombs under the fuselage, Magic 2 missiles, and two 2000-litre fuel tanks.

C.160 Gabriel continued to visit Italy and made at least one stop at Cervia.

The first use of a RP35P reconnaissance pod by the Mirage F1CRs was made at the end of April 1995. This unique and ageing system is based on the RP35 1200-litre (317-Imp gal) fuel tank used by the Mirage F1s. 'RP' stands for 'réservoir pendulaire', or external hanging tank, the suffix 'P' standing for photo; such a designation is also applied to the RP36P based on the RP36 fuel tank, used today by the French Jaguars stationed at Incirlik. The RP35P pod was previously used on the former reconnaissance aircraft of the French air force, the Mirage IIIRs and IIIRDs, and then by the Mirage F1Cs stationed at Djibouti. It can be fitted



This Mirage 2000C is equipped with the large 2000-litre fuel tanks normally used on the strike Mirage 2000D/Ns. This EC 3/5 aircraft wears the black dragon badge of SPA 171 on its tail. The aircraft was based at Cervia, flying escort missions, and usually carried a limited armament of two Magic 2s, due to the wing tanks.

Operation Crêcerelle



Gathering intelligence about exactly what air defence systems were in operation in Bosnia, the Transall C.160Gs of EE 54 'Dunkerque' made occasional visits from their home base in Metz.

RP35P (or less often the SLAR pod) and the second carrying the ASTAC pod. Each aircraft is able to carry any of the three different reconnaissance pods available.

When a detachment goes to Italy for a two-month temporary duty, all the crews come from the same unit and are rotated every two months. It is not the same for the aircraft, which may stay longer. They are usually pooled from all the squadrons of the base where they originate. For example, a detachment led by ER 1/33 would use aircraft from both ER 1/33 and ER 2/33 from Reims, and a detachment led by EC 2/5 would use aircraft from EC 1/5, EC 2/5 and EC 3/5, all from Orange. It is the same for the Jaguars, Mirage F1CTs and Mirage 2000Ns. This situation remained unchanged until 25 May, when an immediate readiness status was ordered by Deny Flight headquarters.

NATO had decided again to show its determination to the Bosnian Serbs and planned a raid against an ammunition depot located near the city of Pale. The raids were executed on 25 May and missions were flown by Mirage

with panoramic 75-mm OMERA 40 and/or 600-mm OMERA 31 oblique and vertical cameras. The panoramic OMERA 40 is today standard internal equipment on the F1CR and the Jaguar only, and not on the Mirage IIIR or the Mirage F1C, which is why this camera was installed in an external pod.

The OMERA 40, which is useful only for low-altitude reconnaissance missions, is not used at all over Bosnia where, for safety reasons, the flights are flown above 5,000 ft (1524 m). The pod is therefore equipped with two 600-mm OMERA 31 cameras, one vertical and one oblique, fitted to port or to starboard according to the tasked objectives. The more powerful 600-mm lenses are an improvement over the F1CR's original equipment (which was only 150-mm), but the pod reveals its age by some limitations in speed and altitude.

To avoid 'fuzziness' of the image, the aircraft has to fly at a constant speed at high level, or to reduce speed at lower altitudes, because the ratio of speed to altitude must stay within accurate limits; these limitations are caused by the camera itself, which does not have a rotating head so the oblique camera is tilted at a fixed angle of 22.5° below the horizon.

Newer equipment

More recent equipment allows greater flexibility. The aircraft is still equipped with an internal 150-mm OMERA 33 vertical camera, which allows the system to record directly on the film such markers as position, altitude, speed and bearing, which the RP35P cannot do.

The RP35P completes the collection of underfuselage pods carried by the F1CRs. The RAPHAEL-TH SLAR pod and the ASTAC Elint/ESM pod (used since December 1994, having been delivered to units only in October 1994) are both produced by Thomson. They allow the French detachment to fly every type

Above right: The Mirage F1CRs used a variety of reconnaissance equipment, including the elderly RP35P camera pod, based on the structure of a 1200-litre fuel tank.

Below right: Also used was the highly advanced ASTAC Elint/ESM pod, making its operational debut. The ability to carry a wide variety of sensors and weapons makes the F1 the most versatile aircraft in the Crêcerelle force.

of mission possible with the Mirage F1CRs. From April 1995 until the end of May, the French flew a regular schedule of two daily missions. A typical mission over Bosnia was undertaken by two aircraft, the first carrying the





F1CRs (with pilots of ER 1/33) and Dutch F-16s. This marked the beginning of a period of more intense activity for KODAK (callsign of the French recce-men). At this point, the crews standing alert in France were recalled in advance of the scheduled date of their return to Istrana.

AS30L attacks

Two days later, on 27 May, three Mirage 2000Ds of EC 1/3 and EC 3/3 arrived from Nancy and shortly afterwards were equipped with AS30L laser-guided missiles. They were reinforced some days later by a fourth 2000D. The normal rotations between aircraft then began, a necessity due to the limited number of airframes available due to technical overhauls. Familiarisation flights were flown with Mirage 2000Ns of EC 2/4, with the 2000N as leader and the 2000D as wingman, followed by night flights. Initially in these mixed flights the Mirage 2000Ds flew without armament (even without the same free-fall bombs as those carried by the 2000Ns), except for the self-defence Magic 2 missiles; this, again, was to husband the limited flight time of the AS30L missiles. Theoretically, the Mirage 2000D is able to carry (and drop) every type of traditional armament used by the Armée de l'Air (except nuclear weapons), but

no trials had been done with the combination of the Mirage 2000D and the type of ordnance supplied by the Americans. This led, once again, to a limitation of the capabilities of the aircraft. On 30 May, four Jaguars from Toul-based EC 11 arrived at Cervia, increasing the number of French aircraft of different types to almost 25, more than the Italian F-104s of 5° Stormo. Due to the presence of the Mirage 2000Ds, no laser-guided armament was planned for the Jaguars, which were fitted with two underwing pods

Mirage 2000Ds of EC 1/3 and EC 3/3 were armed with the AS30L missile, but the missile was not carried in training to prolong its life.

(four rounds of 100-mm rockets) as main armament, one Magic 2 self-defence IR missile under the starboard wing, one Barax jammer under the port wing, and chaff and flare conformal dispensers under the wingroots. For the first time, the Jaguars were equipped with the ELIAS laser-tracking system. The forward part of the underfuselage fuel tank pylon has been



A Mirage 2000C of EC 2/5 at Cervia, with blue and yellow fleur-de-lys and cross of Lorraine tail badges. The fuel tanks retain the blue-green paint scheme for the Mirage 2000N's camouflage. The pilots were no doubt glad to be rid of the bombs they had previously carried, which had adversely affected the handling of their aircraft.

Operation Crécerelle



modified to carry a laser beam tracker, which can track a beam emitted on the ground by a soldier using a laser designator to help the pilot to acquire the target.

The Jaguars began operations a few days after their arrival. They moved to Istrana later in the week, preceding the Mirage F1CRs. The latter

moved gradually, taking off from Cervia and landing at Istrana after their reconnaissance missions over Bosnia. The first ground crews had left Cervia some days earlier to prepare the arrival at Istrana, and the last left after the departure of the last patrols. They were helped in this task by ground transport and one C.160F

Probably flying the last operational missions of its service career, the Mirage IV demonstrated its potent capability as a long-range reconnaissance machine with the CT 52 system. The aircraft were escorted by Mirage 2000s.

Transall, from Orléans-based ET 61. Like other C.160s sent to Italy or Bosnia, this aircraft is equipped with a self-defence system including threat detectors and missile approach detectors fitted on the nose and the tail, together with chaff and flare dispensers fitted on the sides of the fuselage. The Mirage F1CTs, former hosts at Istrana and scheduled to come back with the Jaguars, were kept in France. The French HQ had decided to replace them with the Mirage 2000Ds, and not to excessively increase the number of CAS aircraft in Italy. The F1CTs stayed in France, prior to their detachment to Bangui in the Central African Republic, where, in addition to a number of F1CRs, they would replace the Jaguars.

Rescue patrols

Many French aircraft were in flight over Sarajevo on 2 June, when BASHER 52, USAF Captain Scott O'Grady's F-16C, was shot down by a SAM. In spite of the presence of these SAM threats, the patrols continued in an attempt to contact the downed pilot and find the wrecked aircraft. During the following days the Mirage F1CRs in particular were tasked for this assignment, together with their foreign colleagues. This schedule went on until 8 June, when O'Grady was found by the CH-53 and Cobras of a CSAR mission. The rescue mission

The Jaguar, operated by EC 11 at Toul, again proved its worth over Bosnia. Armed with 100-mm rocket pods, and equipped with the Barax jamming pod under the port wing, the Crécerelle detachment made the first use of the ELIAS laser tracker. Unlike the modified British Jaguars, the French aircraft cannot autonomously designate and deliver laser-guided weapons.





Top: The Mirage IV is unusual in that its radar system is mounted under the belly. Behind the radar is the CT 52 reconnaissance pod.

Above: Barracuda is the only jamming asset used by the Mirage IVP, mounted under the port wing. The lack of more modern systems meant that the Mirage IVP relied to an extent on the Barax and Cameleon systems mounted on its escorts.

also involved one French E-3F/SDCA (callsign CYRANO), which worked with an American E-3 (MAGIC 55), EA-6Bs and EF-111As. The atmosphere eased after O'Grady's recovery, and the programme of flights continued in the same manner.

The Mirage F1CRs and the Jaguars of the French air force, in addition to the Etandard IVPs of the French navy, are not the only French aircraft to fly reconnaissance missions over Bosnia. These light reconnaissance fighters are tasked only for low- or medium-altitude tactical recce missions, whose intelligence reports are directly sent to Deny Flight HQ in Vicenza where analysts use them to advise people in the operational theatre. Some Mirage IVPs of EB 1/91 'Gascogne' from Mont-de-Marsan, and EB 2/91 'Bretagne' from Cazaux, regularly fly high-altitude reconnaissance missions over Bosnia. They are equipped with a CT 52 special container, in which are installed different models of oblique and vertical cameras.

Long-range reconnaissance

The Mirage IVP assignments are in the nature of 'strategic' missions or infrastructure reconnaissance missions, and thus the intelligence reports are not focused on the same objectives and not sent to the same analysts. This type of information is more useful to staff analysts, for example those working at the DRM (Direction du Renseignement Militaire - Direction of Military Intelligence) at Creil. A typical mission involves take-off from Mont-de-Marsan or Cazaux, after which the aircraft refuels and heads for Bosnia. There then follows a rendezvous with a patrol of two Mirage 2000Ns or, sometimes, two F1CRs. These mixed patrols allow the Mirage IVP to take advantage of the protection of its 'little brothers', which



Above: This well-weathered EC 11 Jaguar is fitted with a Barax jammer. The ELIAS tracker is visible on the front of the fuel tank pylon.

are equipped with more up-to-date systems. The Mirage IVP, which was equipped with old devices adapted to older threats, carries a BOZ chaff and flare dispenser under the starboard underwing pylon, and a Barracuda jammer under the port underwing pylon. The Barracuda is the only jamming device carried today by the Mirage IVP. The aircraft has been retrofitted

with the Serval system already fitted as standard on the Mirage 2000, but it is only a threat detector, and the IVP lacks a modern built-in jammer like the Cameleon of the Mirage 2000N or an external pod like the Barax of the Mirage F1CR. After the mission, the Mirage IVP parts company with its patrol mates and returns to France, where it lands directly at Creil, allowing the photographic specialists immediate access to new target information gained on the mission.

Sophisticated self-defence fit for the Mirage 2000C

Mirage 2000C S4s from EC 2/5 'Ile de France' and EC 3/5 'Comtat Venaissin' deployed to RAF Waddington between 9 and 20 October, to take advantage of the British Aerospace ACMI facilities. All aircraft were fitted with the Thomson-CSF Serval RWR system (aerials on each wingtip and the leading edge of the fin), along with a display in the cockpit which displayed signal strength and bearing of threat emitters. Multiple emitters can be displayed and may be accompanied by an audio alarm. Each aircraft was also fitted with the ABD 2000 Cameleon jamming system (ECM aerials in base of tail, detector aerials in leading edge of fin). The ABD 2000 detects and identifies threat emissions, prioritises these, alerts the pilot and automatically initiates the correct mode of jamming for any particular threat in H-, I- or J-bands. The ESM detector sub-system analyses RF, RF agility, PW, PRI, duty cycle and polarisation. The main jamming modes are continuous noise, spot noise, barrage noise, countdown blink and VGPO (Velocity Gate Pull Off). The system will eventually be

integrated into the ICMS (integrated countermeasures system). As part of this upgrade the system will be comprehensively modernised and will be known as the Dassault Electronique/Thomson-CSF Sabre ECM jamming system, already fitted to some Mirage 2000Ds and Ns. Some of the aircraft deployed to Waddington were further modified and fitted with the MATRA Spirale chaff and flare system, two IR detectors and flare dispensers fitted to fairings either side of the trailing edge of wingroots, with two eight-hole chaff dispensers on either side of the underfuselage. There was no indication that the unmodified aircraft had been or can be fitted with the Dassault Electronique Eclair (Aikan LL 5062 chaff and flare system), which is usually scabbed on in place of the braking parachute enclosure. There was no indication that any of the aircraft deployed had been upgraded with the RDY radar system, and both the ground crew and aircrew were reluctant to allow photographs to be taken of the rear view of the Spirale-fitted aircraft.

This close-up view shows the Spirale system's chaff and eight-round flare dispensers. The twin dispensers and their associated IR detectors are mounted on the trailing edge of the wingroots in flush-fitting fairings. Mirage 2000Cs also use the Serval RWR.



BRIEFING

Beech T-1A Jayhawk

SUPT trainer comes of age

The US Air Force is rapidly compiling its planned force of Raytheon T-1A Jayhawk trainers intended to provide SUPT (Specialized Undergraduate Pilot Training) to student pilots assigned to transports and tankers. In just three years, the USAF has moved from training its initial cadre of instructors (see *World Air Power Journal*, Volume 12) to having its fleet near completion.

Ironically, the base where T-1A operations began (Reese AFB, in Lubbock, Texas, which trained the start-up cadre of instructors in the 52nd Flying Training Squadron) is scheduled to close, amid the downsizing of US forces in the 1990s. New T-1A instructors are now trained by the 99th FTS at Randolph AFB at San Antonio, Texas, which is also headquarters for AETC (Air Education and Training Command) and for the Nineteenth Air Force, which oversees AETC flight training.

The 86th FTS/47th FTW at Laughlin AFB near Del Rio has 40 Jayhawks now and will acquire more from Reese when the latter base ('LB' tailcode) shuts down. The other two Jayhawk squadrons are at Vance AFB, Oklahoma (26th FTS/71st FTW, 'VN' tailcode) and, in the near future, Columbus AFB, Georgia (14th FTW, 'CB' tailcode). A milestone was reached in November 1995 when a T-1A logged the 100,000th flying hour for this type without a single serious mishap.

Under the SUPT programme, student pilots destined for multi-engined aircraft types will proceed from the Cessna T-37B Tweet (and its replacement) to the T-1. Their advanced training therefore follows a separate track from that of students bound for bombers and fighters, who still train in the Northrop T-38 Talon. The Jayhawk and SUPT are saving airframe hours on the fleet of ageing



T-38s, which dates to 1959 but is not yet scheduled for replacement.

The T-1A is based on the civil Beechjet 400A, a version of the Mitsubishi MU-300 Diamond, and is powered by two 2,700-lb (12-kN) thrust Pratt & Whitney JT15D-5B turbofan engines. As configured for the AETC, the T-1A has cockpit seating for a student who will fly in the left seat, for an instructor in the right seat, and for another student in a third seat immediately behind. Rails are fitted to accommodate up to four extra seats (usually, two are installed) in the rear cabin, which are useful for passengers on a 'hack' trip but not used for training.

Structural enhancements, as compared to the civilian version, provide for a large number of landings per flight hour, increased bird-strike resistance, and an additional fuselage fuel tank. The T-1A has single-point refuelling and fewer cabin windows than its civilian equivalent.

Raytheon (still better known to most people as Beech) was awarded the contract in February 1990 after other aircraft designs from Cessna (T-47B Citation), Lear (Learjet 31), and British Aerospace (Hawker-Siddeley 125-800) had also been considered. Developmental and demonstration flying was carried out by a stock 400A (registered

The 'glass' cockpit of the T-1 provides good training for the modern transports such as the C-130J and C-17, but is not such a good lead-in for the elderly cockpits of the majority of USAF 'heavies'.

N3145F) which briefly wore US Air Force markings before reverting to civilian duties, and by the company-owned 400T aircraft, modified to be similar to the production T-1A but without the same fuselage configuration, inside or out.

The first production T-1A Jayhawk, known to its manufacturer as airframe TT-1, made its first flight at Beech Field, Wichita, Kansas on 5 July 1991. Test pilots Mike Preston and Bud Francis made the one-hour maiden trip, climbing to 14,000 ft (4334 m) and performing routine first flight checks. Preston and Francis also made a second flight in the T-1A on 5 July, reaching 41,000 ft (12680 m). Beech's first two airframes, TT-1 and TT-2, remain with the company for development work while ship number three, aka TT-3 (Air Force serial 90-0400), was delivered to the USAF in November 1991, two months ahead of schedule.

The T-1A designation has been used before by the Lockheed T2V-1 SeaStar, a US Navy aircraft no longer in service. The Jayhawk name, selected in March 1990, has regional significance in Kansas (the T-1A is manufactured in Wichita) but is also assigned to the US Coast Guard's Connecticut-built Sikorsky HH-60J helicopter. The Jayhawk name for the helicopter was the result of a service-wide contest and is based on the 'J' suffix in that aircraft's designation.

The USAF once planned to acquire 211 T-1A Jayhawks, a figure now reduced to 180. The first production T-1A was delivered in 1992. The first unit to receive the T-1A Jayhawk was the 62nd FTS/64th FTW at Reese AFB.

Training sorties in the Jayhawk average 2.5 hours but can last up to four hours. Simulated low-level airdrops for future transport pilots and simulated air-to-air refuelling for the future tanker pilot are a routine part of everyday flying. T-1A training also emphasises



Above: Students initially fly the T-37B prior to transferring to the T-1A or T-38A for advanced training. The Tweets are flown by the 85th Flying Training Squadron.

Below: The Jayhawk has benign handling characteristics, ideal for simulating the larger aircraft to which students of the tanker/transport stream will graduate.





The 85th FTS flight line is headed by a factory-fresh aircraft. In addition to Laughlin, Jayhawks are based at Vance, Reese and Columbus.

cockpit resources management, communications, and co-ordination among the crew.

The T-1A Jayhawk has been well received by blue-suit flight

instructors and is respected for its practicality and for having the best safety record of any aircraft in the Air Force's inventory. At the same time, its 'bizjet' origins have given

the Jayhawk a plastic instrument panel which is criticised for being a little too delicate, and for having, as instructor pilot Captain Fredric Neumann puts it, "one plastic

knob in particular that snaps off if you breathe on it." Having an off-the-shelf executive jet was a concession to the taxpayer's wallet, but the fragile controls are a minor drawback. "On a C-130 you can adjust the controls with a baseball bat," Neumann points out.

Robert F. Dorr

North American Rockwell OV-10D

BATF Broncos

The US Treasury Department's Bureau of Alcohol, Tobacco and Firearms (ATF), which is under fire from Congress for mishandling recent law enforcement incidents, has attracted further attention by building an 'air force' of 22 surplus North American Rockwell OV-10D Bronco forward air control aircraft. ATF plans to use its OV-10D pool to make nine Broncos airworthy at three locations, and currently has seven examples; the remaining 15 are in storage in the 'boneyard' at Davis-Monthan AFB, Arizona. The agency's efforts to put Broncos into the air (hindered because it has a total of just seven pilots) coincided with summer 1995 Congressional hearings on incidents in Waco, Texas, and Ruby Ridge, Idaho, where the ATF was accused of excesses.

ATF is the US federal government's enforcement arm against major crime involving alcohol, tobacco, firearms, arson and explosives. The detonation of a bomb at a federal building in Oklahoma City in 1995, killing 168 people, was the kind of crime ATF investigates. ATF agents work at great peril, often under cover, against dangerous criminals.

The agency began its aviation role in 1960 with the lease of a Cessna 182. Subsequently, it leased Cessna 182, Cessna 210 and Partenavia P.68 Victors. The Partenavias were deemed difficult to support because fewer than 70 are operated in the US. In 1993, ATF chief test pilot Chris Tardio examined several aircraft types as possible replacements, including the Cessna 337, Shrike Commander and Mitsubishi MU-2. The OV-10Ds, being retired by Marine Reserve Squadron VMO-4 in Atlanta, Georgia (see *World Air Power Journal*, Volume 19), became available under the Defense Reutilization Marketing Operation (DRMO). The DRMO system provides for

the use of serviceable surplus military equipment by federal, state, local and civilian agencies.

ATF is understandably sensitive to this detail. "There are no armaments, laser rangefinders, flare or chaff dispensers, ground mapping radar, or ejection seats installed on the aircraft," says Patrick Hynes, ATF assistant director for liaison and public information. The agency has responded to Congressional inquiries by saying that, "The machine-gun sponsors and barrels that were attached to the side fuselage [of the OV-10] were removed and are incapable of being reattached. When the aircraft were painted [after reaching ATF], the holes to attach the sponsors were filled and snipped, preventing reinstallation of the guns." Lest anyone fear that the Bronco is carrying bombs (though it was never designed to do so), ATF points out that, "Spare fuel tanks are attached to the wings and under the cockpit of ATF's OV-10s."

David F. Brown of the Airborne Law Enforcement Association says that the OV-10 is an ideal plane for surveillance of lawbreakers. "It's a twin turboprop and sounds pretty loud when you're up close to it," Brown says. "But you can circle at 3,500 feet above a scene and not be noticed." The ATF's Hynes says that the OV-10 makes an ideal command ship for a fluid law enforcement situation.

The OV-10 Bronco is no longer in military use in the US but approximately 100 examples of the aircraft are used by the Forestry Service, law enforcement agencies and firefighting departments.

The OV-10Ds, including their former VMO-4 tailcodes and side numbers, are:

BuAer No.	VMO-4 code	Civil reg
155410	MU-516	N471AW
155417	MU-515	N472AW
155486	MU-510	N473AW
155488	MU-513	N474AW
155498	MU-511	N475AW
155501	MU-514	N476AW
155502	MU-518	N477AW

All seven were delivered to ATF by VMO-4 pilots from Atlanta to St Louis Downtown-Parks Airport, Cahokia, Illinois (St Louis area).

All are registered to American Warbirds, Inc., Gaithersburg, Maryland.

The remaining 15 (of 22) ATF OV-10s are in storage at Davis-Monthan AFB, Arizona (as of 28 April 1995), as part of the Navy's official AMARC inventory: 155395, 155409, 155418, 155447, 155451, 155466, 155468, 155470, 155474, 155479, 155481, 155482, 155489, 155492, 155493. At AMARC for the Bureau of Land Management are 155446, 155473 and 155483, while also on the AMARC list is 155499 at Quantico (strike reclamation, for eventual display) plus numerous OV-10s approved for striking from the inventory in September 1993.

Robert F. Dorr



Two of the BATF's OV-10Ds are seen at Manassas, Virginia. The aircraft have been completely demilitarised, including the dearming of the ejection seats, although they do still carry their BuAer numbers on the fin. 'Miss Carolyn', shown above, is registered N477AW.





Airtech CN.235

The CN.235 has often been referred to as a 'mini-Hercules' and, while this may be an over-generous appraisal, it is a reflection of this compact aircraft's versatility. In the 13 years since its first flight the CN.235 has established itself as the small airlifter of choice for air forces around the world, and its Spanish and Indonesian co-producers have many further plans for the type.

From the very beginning, the CN.235 was a strange compromise. When Spain's CASA (Construcciones Aeronauticas SA) and Indonesia's IPTN (Industri Pesawat Ternband Nusantara – Nusantara Aircraft Industries Ltd) announced, in October 1979, that they planned to jointly develop and produce a 35-seat turboprop transport, most industry observers were surprised. Not only were the two partners from hugely differing backgrounds (and experience levels), but the sheer distance between the two production lines seemed to make any co-production arrangement a logistical nightmare. The final configuration that emerged in 1981 was marketed squarely as a commercial airliner, but seemed to boast so many 'tactical' design features that it was virtually an exclusively military design. The bulk of early sales and options were indeed to civil customers but, in the years that followed, the CN.235 became a purely military aircraft – and not merely an airlifter. In a relatively short time it has established itself as a tactical transport without peer, and future high-tech developments will see it make its mark on other roles, such as maritime patrol and electronic surveillance.

In January 1980 Spain and Indonesia signed a joint agreement to develop an all-new 35-seat airliner, with the goal of achieving a first flight by 1983. At first it was expected that the new

aircraft would simply be a stretch of the existing CASA C.212 Aviocar which IPTN had been licence-building (as the NC.212) since 1976. CASA has been in existence since 1923, but IPTN was founded only in August 1976, under the leadership of the charismatic Dr Bacharuddin Habibie, who is still the company President Director. To date, IPTN has assembled nearly 90 NC.212s and various Eurocopter (Aérospatiale and MBB) helicopters, and is committed to other adventurous projects of its own. At the launch of the CN.235, however, IPTN had assembled only 30 of its first batch of NC.212s, with only 30 per cent of indigenously-supplied components. Virtually all of these (and subsequent) aircraft were destined for the Indonesian military and state authorities. The fledgling company seemed to be taking on more than it could chew when it signed up as half of the newly-founded Airtec (later Airtech) Technology Industries, to build the as-yet unnamed 35-seat aircraft in 1980. Although Spain wished to build on the success of the diminutive Aviocar, it realised it had neither the finances nor the domestic market to go it alone on such a major project.

Several years of feasibility studies (between 1972 and 1978) had reinforced the conclusion that Indonesia was the obvious partner. A design team (under the leadership of José L. López-

France is one of only two European customers for the CN.235. After a long battle with proposed military versions of the ATR 42, the CN.235 was selected in 1989, as a Nord Noratlas replacement for the Armée de l'Air. These aircraft are wearing their original CEAM markings.

Ruiz, CASA's director of R&D) was set up at San Pablo, Seville in early 1981. Wind tunnel testing was undertaken at the Dutch NLR facility, as a result of which the early wing/fuselage join and undercarriage fairing designs had to be substantially revised. One hundred Indonesian engineers were dispatched to Europe, before the design was frozen in July. Though IPTN had little say in CASA's essential concept, Indonesian requirements did affect the aircraft's final design.

Paris launch

The formal launch of the CN.235 came at the 1981 Paris air show. The project had already received the backing of the Indonesian authorities which earlier that year had committed to acquire 100 aircraft. The CN.235 would be powered by 1,760-shp (1311-kW) General Electric CT7-7 turboprops, which were chosen in favour of Garrett TPE331s or Pratt & Whitney (Canada) PW100s. The proven and popular, double-shaft CT7s were seen as offering the best compromise between a single-shaft engine's high rpm rate (TPE 331) and the complexity of a triple-shaft (PW100).

The CN.235 featured a high-wing and T-tail, with large fuselage fairings to accommodate the bulky tandem-wheel undercarriage, and had a maximum passenger load of 40. Most significantly, the aircraft featured a decidedly non-airliner-style ramp (as did the Aviocar). Gross weight was posted at 13000 kg (28,660 lb). With a full passenger load range was estimated at 1450 km (900 miles), rising to 3700 km (2,300 miles) with full fuel. CASA was responsible for building the forward and centre fuselage, inboard flaps, engine nacelles and centre wing.

New production facilities were set up at San Pablo (home of the Aviocar), where components from IPTN and CASA's other plant at Tablada were assembled. Later, part of the tail assembly would be supplied by Chile's ENAER, under contract to CASA. IPTN would supply the rear fuselage, outer wing panels and flaps, ailerons and tail, from its new Nurtanio 2 plant, at Bandung. IPTN was also responsible for the fatigue testing programme (though both companies built a fatigue test airframe), at its new Puspitek laboratory (National Centre for Research and Technology) in Serpong, near Jakarta. Ultimately, both companies planned to build three aircraft per month – with a combined maximum total of eight. The question of how to get the components to the two assembly lines had not yet been addressed. It was hoped that building labour-intensive items in Indonesia, where costs were low, would offset the costs of transportation around the globe.

Ambitious timetable

Tooling manufacture began in December 1981, with detail parts entering production in May 1982. Both companies committed to rolling out a prototype each, simultaneously, on 1 September 1983, which would be no mean feat by any standards. Certification and the first production aircraft's maiden flight were slated for 1984. At Paris the CN.235 order book stood at 54, with 18 options – all to airline customers (in Spain, Indonesia and Argentina), with no mention of the Indonesian government interest. The aircraft was then priced at \$3.8 million (\$4.9 million in 1984) and both partners foresaw a market for 1,800 civilian aircraft and a further 600 military examples, of which they hoped to capture 40 and 60 per cent, respectively. Certainly it was hoped that domestic orders would keep the partners busy until export orders were attracted.

The Indonesian military finally committed to purchase the CN.235 in 1982, but in far smaller numbers than anticipated. Other orders continued to accrue, from civil customers. IPTN began to

Wearing a Paris number and devoid of any airline colours, ECT-100 is seen here on an early test flight, with an instrumentation nose probe. Hopes of commercial sales soon evaporated, and so attention turned to the military market.

Right: Spain, and CASA, had the honour of rolling out the first CN.235 purely as a result of an earlier sun rise. The first Indonesian aircraft appeared later the same day. CASA's prototype, ECT-100, was unveiled wearing a dual colour scheme combining the liveries of its first (airline) customers: Prinair, of Puerto Rico, to starboard, and Spain's Aviaco to port.



Left: The second, Indonesian prototype, PK-XNC, followed its Spanish-built partner into daylight on 11 November 1983. Both aircraft were rolled out at the same local time, to a prestige reception. The IPTN aircraft wore house colours.

assemble its aircraft five days ahead of CASA, on 20 March 1982. By May 1982 the first Spanish components were air freighted to IPTN, where production subsequently fell two months behind schedule. Development speeded up, however, as both prototypes entered final assembly on 9 May 1983 and were externally complete by July.

It was with some fanfare that two aircraft were rolled out 'simultaneously' (allowing for local time differences) on 10 September 1983. The ceremony at Getafe, near Madrid, was attended by the Spanish royal family and HRH Princess Döna Elena sponsored the aircraft. Indonesia's President Suharto oversaw IPTN's roll-out at the company's main Bandung plant, in western Java.

That same year EMBRAER's EMB-120 Brasilia, the de Havilland Canada DHC-8 Dash 8 and the Saab SF.340 also made their first

appearances. Like the CN.235, they were all intended as regional/commuter airliners, but the Spanish/Indonesian aircraft could not have been more different in its approach. The Airtech team had built an aircraft which can cope with a rough field and spartan facilities. As a freighter it can carry four LD-3 containers, or two standard 88-in (2.23-m) cargo pallets. The CN.235 can also fly four 860-km (332-mile) sectors without refuelling. The sturdy Messier-Bugatti undercarriage retracts forward into large GRP/Nomex sponsons, on either side of the fuselage. Different tyres are available for civil and military versions and low-pressure tyres are also an option. There are no main undercarriage doors. Instead, the wheels protrude slightly when retracted (saving the weight of the doors and their associated mechanism), and this has a clear advantage in the event of an emergency 'wheels



Airtech CN.235

up' landing. It was obviously hoped that this versatility, coupled with a roomy interior, would compensate for the aircraft's rugged appearance and less than startling performance.

The aircraft itself features a conventional all-metal (mainly aluminium alloys) monocoque fuselage, which undergoes some chemical milling and makes limited use of composites. From the outset CASA was eager to make increased use of its own composite manufacturing ability, as certification and production scheduling allowed. Today, the CN.235's leading and trailing edges of the wing and tail control surfaces, along with the wingtips, fintips and tailplane tips, plus the engine nacelles, ventral fins and nose radome, are all composites. The four-bladed Hamilton Standard 14RF-21 constant-speed, fully-feathering propellers are made from glass-fibre, with a metal spar and urethane foam core. The wing is mounted completely clear of the fuselage, a costly arrangement (in terms of overall weight and aerodynamic refinement), but one which allows an unobstructed 'through' cabin, and avoids additional loads on its pressure shell.

Pressurisation is set at (a low) 3.58 psi (0.25 kg/cm²), largely to allow a straightforward rear ramp design, as a higher pressure demands greater integrity and fuselage sealing, thus increasing overall weight. This limits the CN.235's maximum altitude to 18,000 ft



(5485 m). The ramp is a two-section unit (joined by seven clamps when closed), which is air-operable once the cabin has been depressurised. The upper section (7 ft 9 in x 7 ft 8 in/2.36 m x 2.34 m) retracts upwards, in the same style as the C-130. The lower ramp section is 9 ft 12 in x 7 ft 8 in (3.04 m x 3.34 m). Once lowered, the open ramp sits 4 ft (1.22 m) from the ground. At the rear of the cabin, two doors (port and starboard) can be used for paratropping, but the main passenger door is forward on the starboard side.

CASA soon began military trials with the CN.235, and ECT-135, the first production aircraft, was heavily involved in these tasks between 1988 and 1991. It was then sold to Bophutatswana and is now serving with the SAAF.

The wing is a NACA 653-218 airfoil (one already used by CASA in the C.212), with a constant-chord centre-section. This combines good cruise and climb performance, but dispenses with the complicated double-slotted flaps fitted to the C.212, for ease of manufacture. The leading and trailing edges were also changed, for the same reason. A sizeable GRP 'box' surrounds the wing/fuselage join. The prototypes had 'clockwork' Collins APR-65 instruments as standard, but production CN.235s were offered with the then-revolutionary 'glass' cockpit as an option. A Cat 2 Collins EFIS-85B five screen cockpit is now the standard fit.

Dual first flights

On 11 November 1983 the first Spanish-built CN.235 (ECT-100, *Infanta Elena*) made the type's maiden flight, in formation with a C.212 Aviocar and C.101 Aviojet. It was followed into the air by IPTN's aircraft (PK-XNC, *Tetuko*), which made an 85-minute trip on 30 December, in the company of an NC.212 and NBO-105. José Murga and Guillermo Delgado were at the controls for CASA, and Delgado was also co-pilot for the IPTN first flight, alongside D. E. Mursanto. After spending 9 hours and 25 minutes in the air over six flights, ECT-100 entered a three-week period of ground vibration tests. This was followed by a joint 960-hour flight test programme. The Spanish aircraft was responsible for stall, flutter and high-speed evaluation, along with engine and avionics tests. General handling tests were the responsibility of the Indonesian aircraft, as were hydraulic and fuel system tests.

By now the sales total stood at 106, with 23 options, mostly from the Spanish and Indonesian clients and over half from the Indonesian air force and navy. By the Farnborough air show of 1984 it became common knowledge that the CN.235 flight test programme was not progressing smoothly, and its certification date was pushed back to mid-1985, nearly 12 months later than anticipated. After 170 hours of flying, changes had to be made to the wing leading edges and larger diameter propellers fitted. A constant struggle was waged to keep down the overall weight, which was steadily increasing. A major factor in this was an increase in the aircraft's overall seating capacity from 39 to 44 (maximum) seats. In addition, the dorsal fin was



Above: The Royal Saudi Air Force was the first customer for the CN.235, taking delivery of four aircraft, from CASA, in 1987. All are early-production standard CN.235M-10s and two wear this all-white VIP scheme.

Below: The CN.235 also serves in a standard transport capacity with the RSAF, though all four aircraft can be thus configured. At present, two CN.235Ms wear this tactical camouflage and operate from King Faisal AB, Riyadh.



shortened, ventral fins added, the undercarriage fairings were further reprofiled, and vortex generators added to the rudder and elevator.

At the same time, Airtech announced new military developments of the aircraft, including an armed maritime surveillance version plus ECM and Elint variants. A significant development came in June 1985, when it emerged that negotiations were underway to supply Turkey with up to 50 CN.235s, under a licence-production deal, to replace its C-47s. The CN.235 was in competition with the Aeritalia G222 and de Havilland Canada DHC-5 Buffalo. Finally, a deal was struck for the production of 52 CN.235s (after a series of 'on-again, off-again' announcements by all parties), despite the fact that the CN.235 was by then two years behind schedule.

Certification and improvements

Finally, in June 1986, a provisional certificate of airworthiness was issued for the CN.235 by the Spanish and Indonesian authorities. The IPTN production line had some quality control hiccups and FAR 25 and 121 type approval was only issued on 3 December. The first production aircraft, destined for the Royal Saudi Air Force, made its maiden flight on 19 August 1986. With certification achieved, things began to look up for the CN.235 team. The next major military customer to express an interest was France, which was seeking a replacement for its vintage Nord Noratlases. In December 1986 the first commercial CN.235 was delivered to Indonesia's Merpati Nusantara Airlines, as was the first military version, to Saudi Arabia. The first 30 production CN.235s (15 were built by each partner) were designated CN.235 Series 10 (CN.235-10). These were powered by CT7-7A engines, but production soon moved onto the CT7-9C-powered CN.235-100 series (announced at the 1987 Paris air show), which was fitted with lighter, lower-drag composite engine nacelles (designed by General Electric). The higher powered 1,870-shp (1396-kW) CT7-9Cs could be refitted to the earlier CN.235-10s. All military versions were designed CN.235M (i.e. CN.235M-10). Series 100 aircraft are now further divided into -100 CASA-built examples, and -110 IPTN-built examples.

By 1986 CN.235 production had increased to one per month and new military orders for Botswana and Panama were announced. In May 1987, the actual order book seemed to be open to interpretation. IPTN acknowledged 71 firm contracts, including six for the Indonesian navy, 15 for Merpati and 50 for 'domestic customers', with 93 on option for foreign customers. According to CASA, the CN.235 had attracted 114 firm orders: 57 military and 57 civilian.

Maritime patrol specialist

Development of the promised maritime patrol version quickened with the signing of an order for six by the Indonesian Department of Defence in mid-1987. Although the CN.235 was a co-operative project, IPTN began development of an MPA version entirely on its own, an aircraft that was quite distinct from the subsequent maritime version offered by CASA. By December 1989 IPTN's CN.235 prototype (PT-XNC) had been converted to become the CN.235 MPA trials aircraft. An extended nose



Above: A trio of Moroccan air force CN.235M-100s (nearly half the fleet) flies in formation, prior to delivery. Upon the delivery of its seven aircraft in 1990 for a short period Morocco became the largest military operator of the type.

Below: Early paratroop trials were undertaken with one of the aircraft destined for Ecuador, which wore this three-tone green scheme. Three CN.235Ms were delivered to the Ecuadorean armed forces in 1989.





Above and left: The much-modified IPTN CN.235M-10 prototype, PK-XNC, now serves as the CN.235MPA demonstrator. IPTN is now reportedly considering changing the entire MPA airframe and systems configuration, by moving the FLIR and radar to the nose and underside, as CASA have with their version.

was fitted to the aircraft housing a Litton APS-504(V)5 search radar (and IFF), while fairings for a Marconi Sky Guardian 300 ESM system were added above the cockpit and at the bottom of the fin, to the rear of the tailplane. A FLIR turret, housing a GEC TICM II MRT-S (Multi-Role Turret System) FLIR, was fitted under the fuselage, forward of the undercarriage fairings, offset slightly to port. In addition, the MPA gained two underwing hardpoints for carriage of AM 39 Exocet and AGM-84 Harpoon ASHMs or Mk 46 torpedoes. By November 1990 PT-XNC had completed its initial aerodynamic verification tests, checking out the configuration of the new radome, ESM and FLIR fairings along with external fuel tanks and underwing weapons (Harpoon).

Indonesian 'Sky Guardian'

The MPA made its public debut at the 1991 Dubai air show, sporting a huge sharkmouth (with eyes, almost hidden in the black cheatline) and was referred to, by IPTN, as the 'Sky Guardian'. Since then, however, no official name has been applied to the type, beyond CN.235 MPA. Indonesia's need for such an aircraft is obvious. The country itself is an archipelago of 13,500 islands, of which 6,000 are inhabited. The availability of an affordable, indigenous maritime patrol aircraft would greatly ease the burden of customs, anti-smuggling, border patrol, fisheries/EEZ protection, and search and rescue missions, currently maintained by a small number of SLAR-equipped Boeing 737s and C-130Hs.

The CN.235 MPA has an eight-hour endurance (with a 16000-kg/35,273-lb MTOW) and consoles are provided in the cabin for a

tactical commander (TACCO) and sensor operator (SENSO), along with an observer's station. The TACCO is the designated mission commander, the SENS0 is responsible for surveillance systems management (and also inflight test duties), while the observer is on hand to record (photograph) any surface contacts. The substantial amount of sensor inputs (from the FLIR, radar, nav systems, IFF and ESM) are managed by the IPTN/ARGOSystem DPDS Tactical Integrator System (TIS). The TIS is built around a MIL-STD-155B databus and a synthetic radar, colour MFD display to co-ordinate all data at a single workstation.

MPA prime systems

The CN.235 MPA's prime sensor is a Litton Systems Canada APS-504(V)5 frequency-agile radar, designed for ASW and optimised for sea surveillance missions, with secondary navigation, mapping and weather functions. Against small targets the radar's high pulse compression rate allows it to detect very small targets in rough seas at 25 miles (40 km), and it can map out to 230 miles (340 km). Coupled with the APS-504(V)5 is a Cossor 3500 IFF interrogator, an advanced 1030-Mhz (transmitter)/1090-Mhz (receiver) dedicated air-to-air/surface target identification and location system. The same system is also fitted to Indonesia's Boeing 737 Surveiller patrol aircraft. The Cossor 3500 operates in modes 1, 2, 3/A and 3/C and can detect targets as far as the search radar's 180° azimuth.

To confirm an ID on a suspicious contact at night or in bad weather the MPA can rely on a GEC-Marconi Avionics Ltd (Electro-Optical Surveillance Division) TICM (Thermal Imaging Common System) FLIR. TICM is a high-

resolution FLIR developed for the UK MoD. The MPA's FLIR turret provides 360° coverage in azimuth and 180° in elevation and can be slaved to the TIS to find a target detected by the SENS0, who also has full manual control of the unit. The MPA has been designed to operate in a potentially hostile environment, surrounded by dense radar/emitter signals. To cope with this, it relies on a GEC-Marconi Sky Guardian 300 ESM system. Sky Guardian is an airborne system designed to detect and identify radars beyond their accurate detection range, identify their mode (search, track or fire-control) and prioritise the threat they pose to the MPA. To do this, it relies on an array of sensors with 360° coverage and a DF accuracy better than 2.5° against other radars. It uses a 32-bit, ADA-controlled processor which can identify any emission from a 2,500-entry (flight-reprogrammable) 'threat library' and display it within one second of intercept. Sky Guardian 300 typically covers signals in the E-to J-bands (2 to 18 Ghz), although this can be expanded to C- to K-bands (0.5 to 18 Ghz). Once the MPA has found its target a stabilised medium-format camera is carried in a bulged observation window to collect the hard evidence. Development and operational tests of the mission avionics were completed in September 1994.

Fit for the mission

This would appear to be the equipment fit selected by the Indonesian air force/navy for its CN.235 MPAs, although IPTN has acknowledged some other systems it considers as suitable, including alternative radar (Texas Instruments AN/APS-134(IW), GEC Ferranti Seaspray 4000, Thomson-CSF Ocean Master), ESM (ARGOSystem AR-700, Litton ALR-85(V)1), FLIR (Thomson-TRT CHLIO), TIS (Racal TMS, Teledyne TMS), nav systems, MAD, sonobuoy launcher and acoustic processor.

A typical EEZ patrol mission could involve a 75-minute, 150-nm (172-mile, 277-km) transit to the operational area and further seven hours and 10 minutes on station, followed by the same journey home. For a typical SAR mission (an expanding square search, from a last known position) the MPA can carry a load of life rafts and rescue flares for a seven-hour search after a 100-nm (115-mile, 185-km) transit. The rear

ramp remains operable in flight for the dropping of life rafts and provisions. Finally, in attack configuration with two AGM-84 Harpoon-sized missiles, the MPA has a 200-nm (230-mile, 370-km) radius of action, with a six-hour search for a target, increasing to eight hours endurance with just one missile. At the moment, IPTN's MPA is still in the development phase and no aircraft have been delivered.

Irish ocean patroller

CASA has produced its own maritime patrol version, the CN.235 MP Persuader, which is in regular, daily service with the Irish Air Corps (IAC). CASA began to develop the Persuader in 1990 and, while it is similar in concept and equipment-fit to the Indonesian MPA, there are some significant differences. Like the MPA, the Persuader carries an AN/APS-504(V)5 search radar, but this is fitted in an underfuselage radome rather than an extended nose. Under its unmodified nosecone is a FLIR Systems FLIR 2000HP, in a rotating mount. The US-designed FLIR 2000HP is a high-performance digital FLIR that utilises a mercury-cadmium-telluride detector, which can output to a TV display, CRT, video tape or real-time datalink. This equipment fit was trialled in CASA's CN.235 prototype ECT-100, which was repainted in a white and Dayglo 'maritime patrol' scheme, closely resembling that worn by the (interim) CN.235M then in use for transport and limited patrol duties with the IAC. All systems are integrated through a Litton/CASA TDMS (Tactical Data Management System), which, in IAC service, is operated on each mission by three airborne radar and sensor operators

Above right: EC-100 (formerly ECT-100) served as the CASA CN.235MP Persuader prototype. The CASA design features many of the same systems as the IPTN MPA, but externally the two maritime patrollers look quite different.

Right: The first nation to deploy a maritime patrol CN.235 was Ireland, which now operates two CN.235MPs on fisheries protection and surveillance duties, from Baldonnel. The CN.235MPs replaced an interim CN.235M.



Above: The rear ramp of the Irish CN.235MP houses air-droppable life rafts and survival gear.



Above right: The undernose FLIR 2000HP is an invaluable SAR tool and the CN.235MP is the only IAC type thus equipped.

Right: The late-model CN.235M-100 cockpit, such as this MP, has several differences over older aircraft, notably the inclusion of CRTs in place of electro-mechanical instruments. The pilot has cueing controls for the FLIR (on the yolk), which is displayed on the large screen beside the weather radar. This screen can also display the search radar, though only in black and white.





Fifty of the 52 CN.235Ms on order for the Turkish air force will be built, under licence, by TUSAS/TAI, using locally supplied components. This Turkish company is also responsible for building the air force's F-16s and SF.260 trainers.

(AROs). A separate datalink operator is carried, along with a photographer/observer. The Persuader carries a 70-mm Agiflite stabilised camera which is tied into the CN.235 MP's inertial navigation system and prints the latitude/longitude of each photograph taken onto the negative. The Persuader is offered with a Litton AN/ALR-85(V) ESM/RWR system, but this is not fitted to the two IAC aircraft. Two CN.235 MPs were delivered to the Air Corps in December 1994, and have served both as effective maritime patrollers and vital operational testbeds for the CASA engineers.

The CN.235-200 and beyond

In an attempt to revitalise the stagnant civil market for the CN.235, in 1990 CASA introduced the CN.235-200, which is now the standard production version. Only 23 CN.235s are in airline service, chiefly in Indonesia (where the law requires carriers to buy IPTN aircraft)

but also in Spain and Argentina (on lease). The many options once held by Airtech evaporated and the firm orders were cancelled, in a clear signal that the CN.235's novel design features were of little attraction in the cut-throat commercial world of commuter airlines. With the Series 200 Airtech hoped to remedy this by producing an aircraft with almost double the range of its predecessors. A structural redesign to allow a higher MTOW, coupled with aerodynamic refinements to the wing leading edges and rudder, boosted the CN.235-200's range (with maximum payload) to 957 nm (1,773 km, 1,102 miles), compared to 450 nm (834 km, 518 miles) for the CN.235-100. With maximum fuel this range climbed to 2,110 nm (3908 km, 2,428 miles), compared to 1,974 nm (3656 km, 2,272 miles).

The CN.235-200 was certified by the FAA in March 1992, although none has yet been delivered to any military customers. Spanish-built aircraft

will be CN.235-200s and IPTN built aircraft will be CN.235-220s. The first operator will probably be Indonesia's Merpati Nusantara Airlines, which in November 1994 ordered 16 CN.235-200s for delivery between 1995 and 1998. Merpati already has 14 CN.235-10s.

Another new version, the CN.235QC (Quick Change) convertible passenger/cargo version, was certified in May 1992 by the Spanish DGAC. CASA used aircraft no. 42 (EC-764) for the trials and certification programme. The military freighters have completed LAPES qualification tests and the CN.235M is now capable of air dropping up to 4000 kg (8,818 lb) of LAPES pallets, one at a time (per pass).

By late 1995 CN.235s were in military service with 17 nations, on option/order with three others (not including additional orders for existing operators) and in the running for yet more significant orders. The current operators are presented below, in chronological order.

Saudi Arabia

Following a visit to Spain by the then Saudi Defence Minister, Prince Sultan Ibn Abdulaziz, Saudi Arabia contracted to purchase four CN.235-10s as part of an overall £105 million purchase of Spanish military equipment. This order was later rumoured to have increased to 10, but, in the event, only four were delivered. The first aircraft was handed over to the Royal Saudi Air Force on December 1986, to Colonel Saud M. Al-Betaawi, at San Pablo. Deliveries were complete by April 1987. Two of the CN.235s are configured as VIP transports, while the others are convertible passenger/freight versions, with a roller floor. All are flown by No. 1 Sqn from King Faisal AB, Riyadh.

Botswana

The first of two CN.235Ms for the Botswana Defence Force was handed over in January 1988, at San Pablo, to Colonel A. Scheffers, commander of the Defence Force's air arm. The aircraft were delivered with 48 troop seats and configured for paratrooping, with static line fixtures at the rear doors. In addition, a 12-seat VIP transport kit and a 38-seat transport interior were supplied. The CN.235s replaced a pair of Britten-Norman Trislanders, which was later sold in the USA. Operating unit is the Botswana



Above: Botswana was the second African customer to acquire the CN.235. Two were delivered in 1987 and 1988.

Right: Strangely, Spain did not acquire the CN.235 until 1989 when two CN.235M-10s (T.19A) were delivered. The air force was obviously unimpressed with the performance of this early version as further deliveries (of CN.235M-100s/T.19Bs) did not commence until 1991.



Right: Chile became a CN.235 operator in 1989 when this, the first of three CN.235M-100s, was delivered for use by the army. Chile also holds the distinction of being the only customer (to date) to lose a CN.235 when aircraft 217 was damaged beyond repair, after a landing accident at Teniente March air base, in February 1992.

Below: The Moroccan CN.235s filled a transport gap below the air force's C-130s. The CN.235s compliment a substantial fleet of CH-47s and SA.330s in the tactical transport role. They are infrequent visitors to Europe.



Defence Force's Z1 Squadron (air transport), at Francistown.

Panama

Panama was already a CASA C.212 operator when its Servicio Aéreo Nacional announced an order for a single CN.235M, in late 1987. The new aircraft joined two C.212A-200s acquired in 1982, and a follow-on order for C.212-300s was placed at the same time as the CN.235. The SAN is based at Panama City.

Spain

Spain's Ejército del Aire accepted its first two, of an initial batch of 20, CN.235s in 1989. Both were configured as VIP transport T.19As (initially T.19C) and delivered to Ala 35, at Getafe, near Madrid. The remaining 18 were camouflaged T.19B tactical transports and these are now being repainted in an overall grey scheme. The CN.235s replaced smaller CASA C.212s with Escuadrón 351 and 352, and the Aviocars were transferred to Ala 37. Currently, one aircraft is permanently configured for aircrash duties in support of the Spanish UNPROFOR contingent in Bosnia. Spain has a further requirement for six maritime patrol variants.

Ecuador

Three CN.235s are believed to be in service with the Ecuadorean armed forces, split equally between the air force, the army and the navy. The Aviación Naval Ecuatoriana's (naval aviation) 2 Escuadrilla (No. 2 Flight), based at Guayaquil,

took delivery of a single example in 1989. In the same year, the Aéreo del Ejército Ecuatoriano (army aviation service) took delivery of a single VIP-configured aircraft. The army aircraft is part of Grupo Aéreo 43, of the 19^a Brigada Aérea del Ejercito, based at Simon Bolívar Airport, Guayaquil. Some confusion exists over the Ecuadorian order as, according to official CASA data, only two aircraft were delivered, and other sources state that c/n 15 (which has been reported as AEE-502) was never completed.

Chile

The Fuerza Aérea de Chile was already a C.212 customer when it contracted (in principle) to acquire a batch of six CN.235Ms in 1988. Only three aircraft were delivered, in 1989, and one of these crashed in 1992 – the only CN.235 lost to date. The remaining aircraft are now in service with the Comando de Aviación del Ejército de Chile (army aviation command).

Morocco

The Royal Moroccan Air Force placed an order with CASA for seven CN.235Ms in 1989. Deliveries were delayed (most probably by funding difficulties) by over a year and the 10 aircraft held in storage at Seville, until handed over in September/October 1990. The type was selected after an operational evaluation held at Salé and Kenitra in December 1988. The Pts 11,000 million (£360 million) purchase was funded as part of a military co-operation agreement with Spain, which provided a total of Pts

125 billion (£680 million) in credit for Spanish goods. The CN.235s are an important part of the air force's transport assets, and supplement far larger C-130s. One CN.235 is a permanently configured VIP aircraft.

Bophutatswana (South Africa)

The sole CN.235 delivered to the 'Bop' Air Force was CASA's first production aircraft (ECT-135). It arrived at Mmabatho airport in January 1991, configured for paratrooping, troop transport and all-freight duties. Bophutatswana was one of South Africa's 'independent' homelands and its air force was already a C.212 operator. With the change of regime in South Africa in May 1994, the homelands were reintegrated and their air forces assimilated into the SAAF. The CN.235 joined No. 86 Multi-Engined Flying School, at Bloemfontein, as the only example of its type in South Africa Air Force service.

France

French evaluation of the CN.235 as a Noratlas replacement for the Armée de l'Air began in spring 1987. Dassault-Breguet supported a bid to supply 25 aircraft, under a Ff 700 million (£74.95 million) contract. In fact, the CN.235 was the only real contender for the order. ATR proposed a militarised version of the ATR 42 commuter turboprop, the ATR 42L, which would be fitted with a new side-loading cargo door (2.95 m x 1.74 m/2 ft 7 in x 5 ft 7 in). Aérospatiale got as far as building a fuselage mock-up and suggested that deliveries could begin by 1990, but when compared to the (in production) CN.235, and its rear ramp, the winner was clear. ATR went on to develop the ramp-equipped ATR 42R, but it was never built, and subsequent military developments (ATR 42F, ATR 42C) have proved equally unsuccessful.

A letter of intent for the CN.235M was signed for eight aircraft, with options on another seven, at a unit cost of Ff 51 million (£4.7 million). Despite this, by the 1989 Paris air show it seemed certain that the French acquisition would be scaled down to only two aircraft, with four options, for delivery in 1992/93. This was confirmed when the 1990 budget allowed funds for only two aircraft. This pair was delivered in 1991, and was followed in 1993 by four more examples. All entered service with the CEAM (Centre d'Expériences Aériennes Militaires), the

Airtech CN.235



Left: The first production CN.235 was sold to Bophutatswana in January 1991 and flown by the 'Bop' air force from its main base at Mmabatho. With the reintegration of the former-homelands' armed forces into the main SAAF establishment, this aircraft joined No. 85 Multi-Engined Flying School.

Below: French CN.235s were initially delivered to the CEAM test establishment, at Mont-de-Marsan, but are now in regular service with ETL 1/62, at Creil-Senlis.

French air force's test and trials unit at Mont-de-Marsan, and were operated by EET 6/330, CEAM's transport unit. They have since moved on to an operational unit, ETL 1/62 (Escadron de Transport Léger/light transport squadron) 'Vercors', based at Creil-Senlis. The French air force has options on an additional seven aircraft.

Gabon

A single CN.235M was delivered to the Armée de l'Air Gabonaise in 1991, supplementing the air force's eclectic transport fleet of EMBRAER Bandeirantes, Nord 262s, Lockheed L-382s and the sole ATR 42M. Two CN.235s have been reported in air force service (wearing Gabonese civil registrations, as do all the air force's transport fleet) but only one delivery (TR-KJE) is confirmed by official sources. The Gabonese air force's transport unit is the Escadron de Transport Léger, based at BA 01, Libreville.

Ireland

Irish interest in the CN.235 grew in parallel with the development of maritime patrol versions. Safeguarding Ireland's rich territorial waters from illegal fishing, and a growing drug smuggling problem, was the responsibility of the country's overstretched naval service and two less than suitable maritime patrol Beech 200 Super King Airs flown by the Irish Air Corps. A plethora of contenders was evaluated (including the Maritime King Air, DHC-8 Dash 8, Dassault Guardian, Do 228, Fokker F27, BAe 748 Coastguarder and the CASA C.212) before the CASA-built CN.235MP was selected in 1991. A European aircraft was always the only choice, as the £20.9 million purchase was funded in half by the EC (as was an expansion of the naval fleet). A contract for two aircraft was signed in 1991, but the aircraft that became known as the Persuader was not then available and a single interim CN.235M was acquired instead. It arrived at the IAC's main base of operations, Baldonnel, on 6 June 1991. It had none of the sophisticated mission avionics of the MP, and had acted as one of the CN.235M trials aircraft with CASA – as such, it had some decidedly non-standard features.

The 'CASA', as it was universally known, wore a Dayglo and white high-visibility 'maritime' scheme (similar to that of the King Airs) and undertook regular patrols of the Irish EEZ, to the west and south of the country. It was equipped with a digital datalink in the rear cabin to report on suspicious contacts, one that could



not be intercepted by the scanners of increasingly well-organised and sophisticated illegal trawlers from the continent. The aircraft also undertook transport missions, both freight and transport (including carrying a damaged SF.260 to the Milan factory for repair), aircrash flights, and paratroop sorties with the army. During 1992 104 patrol missions were flown, rising to 214 in 1993. After the arrival of the two new aircraft, the original 'CASA' returned to Seville on 16 January 1995.

The dedicated CN.235MPs arrived together on 8 December 1994. Their official designation was CASA CN.235-100M/IR-01, and they were delivered wearing the strange (CASA-applied) serials IFP252/253 – since revised to standard Air Corps form. They also wore a very low-visibility overall grey/blue colour scheme, with black 'Irish Air Corps' fuselage titles and tri-colour on the fin. The day after its delivery, 252 flew its first maritime patrol, although 253 was returned to CASA for final fitting-out between 10 December 1994 and 28 January 1995. Both MPAs are flown by the Maritime Patrol Squadron, No. 1 Support Wing, and based at Baldonnel-Casement aerodrome.

Indonesia

TNI-AU (Tentara Nasional Indonesia - Angkatan Udara)/Indonesian air force

The Indonesian government originally expressed an interest in 100 aircraft, but when it signed its first firm commitment (in October 1982) to purchase the CN.235 it ordered 32 aircraft, with deliveries to begin in 1985/86. Three versions were specified: cargo transport, paratroop transport and maritime surveillance.

In 1986 the TNI-AU issued a requirement for additional maritime patrol aircraft to supplement the three SLAR-equipped Boeing 737s then in service. Dr Habibie lobbied hard for support for a version of the CN.235 to undertake that role.

The first two (of an initial batch of six), CN.235Ms were not delivered until the end of 1991, to Skwadron Udara 2 (No. 2 Flying Squadron) at Jakarta/Halim-Perdanakusumah AB. They were not operational aircraft and were still involved in IPTN's trials programme. Indonesian military CN.235s are fitted with a reprofiled nose radome, for reasons unknown (despite carrying the same radar as CASA-built aircraft), and deliveries are proceeding at a slow rate, with 32 still on order (in total).

TNI-AL (Tentara Nasional Indonesia-Angkatan Laut)/Indonesian naval air arm

Soon after the air force order, the Indonesian navy announced a requirement for 18 CN.235s. This interest crystallised in the shape of a 1987 order for six maritime patrol aircraft. The deal was signed by the Armed Forces C-in-C, General L. B. Moerdani, on behalf of the Department of Defence and Security and, in addition to the aircraft, included pilot and ground crew training, maintenance and logistical support. Deliveries were scheduled for 1989, and the new CN.235s were destined to replace the GAF Nomads then in service with No. 800 Sqn, at Surabaya. As yet, however, no MPAs have been handed over to the TNI-AL.

Papua New Guinea

A pair of CN.235s was ordered by the Papua-New Guinea Defence Force (PNGDF) in October 1991 and delivered the following year.



They fly alongside a variety of transport-configured GAF N.22s and UH-1Hs, from Port Moresby. The PNGDF's original requirement was for four CN.235s to replace the five C-47s and three IAI Aravas then in service.

Turkey

Turkey and Airtech haggled throughout the 1980s over a licence-production deal for the CN.235, which ultimately lead to the establishment of TAI and an agreement to produce 52 aircraft. The preliminary contract was signed by the Turkish government only in December 1990. The £375-million, seven-year production deal was financed to a large degree by the Spanish government, with a loan repayable at only three per cent over 20 years, with 10 years' grace. 15 May 1984 saw the foundation of TAI (Tusas Aerospace Industries Inc. – TUSAS Havacilik ve Uzay Sanayi A.S.) to assemble 50 of the 52 aircraft required by Turkey. TAI was formed by an eclectic group of shareholders, including TUSAS itself (49 per cent) along with Lockheed of Turkey Inc., General Electric, the Turkish Armed Forces Foundation and the Turkish Air League (0.1 per cent). The aircraft are assembled at a 230-ha (568.3-acre) site that also produces F-16s, SF.260s and UH-60s under licence. The first Turkish-built CN.235M made its maiden flight on 24 September 1992 and deliveries began on 13 November. By the end of 1995, 20 had been delivered to the Türk Hava Kuvvetleri (Turkish air force). The local component content of the TAI-built aircraft now stands at 93 per cent. The CN.235 was intended to replace the C-47s in service with 12 Ana Üs, based jointly at Erkilet/Kayseri and Etimesgut, as part of the second Tactical Air Force, Hava Ulastirma Komutanligi (Air Transport Command). All the C-47s were slated for retirement in 1995, but it seems certain that the elderly 'Daks' will survive for some time to come. The CN.235s are now in service with 223 Filo and 224 Filo (both based at Etimesgut) and 1 THKIKK. Two aircraft wear an all-white VIP scheme and the fleet will eventually be spread among various base flights also.

Above: Indonesia is an obvious CN.235 customer and most of the civilian aircraft built are in service there. The air force has 32 CN.235Ms on order and MPAs will follow.

Right: South Korea acquired 12 CN.235s in 1993/94 to replace its long-serving Fairchild C-123s.

Oman

The Omani Police Air Wing placed an order for two CN.235Ms on 15 February 1992. Both were delivered in January 1993. The civil-registered aircraft are operated alongside a DHC-5 and two Dornier 228s, in addition to numerous Bell helicopters and two VIP Learjets.

South Korea

The Republic of Korea Air Force ordered 12 CN.235Ms on 19 August 1992 and deliveries began (via Hong Kong) in November 1993. Ten had arrived by the end of February 1994 and all are now in service. Their CN.235s were delivered as Fairchild C-123 replacements and serve with the Pusan-based Air Transport Wing.

United Arab Emirates/Abu Dhabi

Abu Dhabi became the first export customer for IPTN when it took delivery of the first of seven CN.235Ms ordered, on 31 August 1993. The first public appearance of a UAE air force CN.235 (811) was at the 1994 Dubai International air show, held in November that year. Abu Dhabi's military aircraft are allocated to the United Arab Emirates Air Force's Western Air Command, and are largely based at Al Dhafra AB. However, the Transport Squadron is stationed at Bateen AB. The UAE is a much touted potential customer for a maritime patrol version of the CN.235, though it is reportedly unhappy with the technical support obtained from IPTN thus far.



Brunei

The first outside interest in a maritime patrol version of the CN.235 came from the Kingdom of Brunei in 1989. It expressed an interest in three or four IPTN-built aircraft for the Air Wing of the Royal Brunei Armed Forces. The requirement was not immediate, and not intended to be fulfilled before 1993, at the earliest. In November 1994 the Sultan of Brunei met with the IPTN Chairman Dr Bacharuddin Habibie and announced that Brunei would indeed place an order for three CN.235 MPAs by March 1995. A fourth standard CN.235M would also be acquired for crew training. This order does appear on CASA's official order sheet, and no firm delivery date has been announced, though the first of the MPAs should now be handed over in 1999. Acquisition of the MPA was held up by competition from CASA, infrastructure changes in the Air Wing itself, and the question of which contractor would be selected as Brunei's systems integrator. ARGOSystems was declared the winner in November 1995 with a formal contract to be signed by May 1996. However, a systems fit has not yet been decided and Brunei is believed to prefer a more modern radar than APS-504. The MPAs will be flown from the Royal Air Wing's new base at Bandar Serti Begawan. They will undertake surveillance missions along Brunei's vital sea lanes and resource-rich territorial waters and may be a factor in reinforcing Brunei's claim to the hotly-contested Spratly Islands.



This UAE CN.235 displays the type's undercarriage access doors which allow easy access to the gear, while also providing a make-shift platform for engine work or access to the wing and control surfaces.



Malaysia

Under the terms of a May 1994, \$100-million agreement, IPTN will supply the Malaysian air force with an initial six CN.235s as replacements for its DHC-4 Caribous. Malaysia currently has 13 Caribous in service (with Nos 1 and 8 Sqns) and may eventually acquire a total of 18 CN.235s. A memorandum of understanding was signed between the two nations during a visit in May 1994 to Indonesia by the Malaysian Defence Minister Najib Abdul. In return, Malaysia will supply Indonesia with 20 SME Aerospace MD3-160 (formerly Datwyler, now built under licence in Malaysia) piston-engined, light training aircraft, NAS.332 Super Pumas and up to 1,500 Proton automobiles. Deliveries of the CN.235s will commence in 1996. The deal was first announced at the LIMA (Langkawi International Aerospace and Maritime) exhibition in Malaysia in December 1993, where the CN.235 MPA was exhibited. At that time an announcement was made to the effect that Malaysia would acquire 32 aircraft from IPTN (becoming its biggest customer), including several CN.235 MPAs, even though the Indonesian statement mentioned only 'transport aircraft'. IPTN's Dr Habibie stated that

three aircraft would be delivered to Malaysia 'as soon as possible', but to date none has been handed over. Instead, under the terms of the 1994 MoU it seems that a small number of aircraft will be delivered from 1996.

Jordan

Early in 1986, IPTN announced that it had sold two CN.235s to the Royal Jordanian Air Force. Nothing has been heard since of this deal, but it is believed that these aircraft may still be on IPTN's order books.

The CN.235 is currently in the running for several major orders. Responsibility for marketing the aircraft is supposedly split between the Airtech partners on regional grounds. IPTN handles sales in Asia, the Pacific and North America, while CASA is responsible for Europe, Africa and Latin America. In practice, the overwhelming majority of aircraft in service are CASA-built, raising some questions about the availability (and quality) of IPTN's product.

In 1996 Australia will issue a formal requirement for a medium-/tactical-transport to replace its vintage DHC-4 Caribous. At one time it was suggested that a mix of CH-47D Chinooks and C-130Js would take the

A Spanish CN.235, wearing the tactical camouflage now being replaced by an overall grey scheme, embarks a load of paratroops for a jump exercise. Troops always jump from the two rear side doors.

Caribou's place, but Australia will instead acquire an all-new transport type. The recent withdrawal of the GAF N.22 Nomad from service makes an aircraft in the class of the CN.235 all the more desirable. Several manufacturers are lining up to compete for the order, including both CASA and IPTN who are both offering the CN.235, in separate bids. IPTN has signed an MoU with Hawker de Havilland (Australia) and Honeywell to cover airframe manufacture and avionics integration in the event of a successful bid. IPTN is offering a new version, the CN.235 Series 330 Phoenix which incorporates several systems improvements. The Australian requirement will necessitate an increase in take-off performance and also a combi configuration, with an option for surveillance duties. Honeywell would be responsible for integrating a MIL-STD 1553B databus with the aircraft systems, including a new self-protection (chaff/flare) suite, ARL-2002 (RWR and ESM) fit, INS and GPS. The NVG cockpit will also be cleared for operations down to 700 ft (213 m).

IPTN is proud of the fact that the CN.235 is still the only production military transport in its class with a full NVG-compatible cockpit, as standard. Development tests with Generation III NVGs and filters began in 1992 and deliveries commenced the following year.

In November 1995 the United Arab Emirates was to announce its choice of a new maritime patrol aircraft – a competition the CASA-built CN.235 MP is expected to win. The addition of Russian-built 'Kilo'-class attack submarines in the Iranian navy has provoked a rapid reassessment of ASW capabilities among many of the Gulf states and the UAE is expected to order between four and six aircraft (IPTN believes seven) to answer to the perceived threat. Those in the running for the \$100+ million contract included the Lockheed Martin P-3C and Fokker's Maritime Enforcer. One of the reasons the CN.235 is seen as the front runner is that its lower price will enable more aircraft to be acquired. The CN.235M is already in service with the UAE air force and CASA has also announced that it will set up a tile-manufacturing plant in the UAE as part of an industrial offset deal. The UAE decision may well be a powerful influence on the future plans of the other Gulf Co-operation Council members.

Other likely customers may include Thailand, along with additional aircraft for Malaysia and Indonesia. Having lagged behind its European partner for some years, IPTN may soon gain the upper hand in the orders stakes.

Planning the way ahead

Both partners have deservedly high hopes for the CN.235, which now has a proven service record and obvious development potential. Only one aircraft has been lost in an accident and all those who have flown the type speak highly of it. IPTN has upped its production

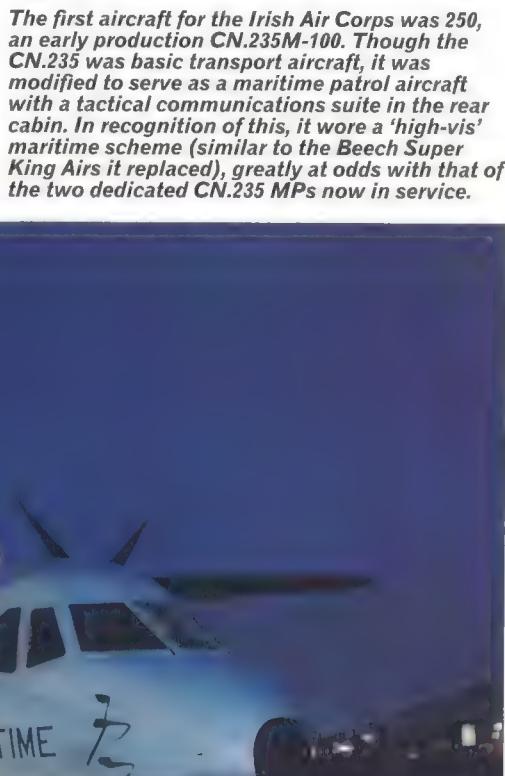
capability to 8/10 per year with a view to increasing that further to 14/16. Recent civil orders, 16 CN.235-220s for domestic carrier Merpati, will see the company through until the MPA comes on stream. The option of re-engineing the aircraft remains open, and may be spurred by the final performance requirements of the RAAF. At the moment the CN.235 is offered with only a partial 'glass cockpit'. By the year 2000 this will have been replaced by a fully-electronic fit with colour LCDs replacing CRTs in three to four years. Development is also proceeding of an Elint version, perhaps with a SLAR. By January 1995 stated sales had reached 210, with 119 delivered (not including five manufacturer's trials aircraft) and that number is sure to significantly increase during 1996.

Robert Hewson

AIRTECH CN.235 MILITARY DELIVERIES

C/n	Variant	Serial	Delivery date
Saudi Arabia			
002	CN.235-10	118	3.2.1987
003	CN.235-10	119	3.2.1987
004	CN.235M-10	126	15.7.1987
005	CN.235M-10	127	15.7.1987
Botswana			
008	CN.235M-10	OG1/Z1	21.12.1987
009	CN.235M-10	OG2/Z1	15.3.1988
Panama			
011	CN.235M-10	265	6.9.1988
Spain			
013	CN.235M-10	T.19A-01/35-60	7.12.1989
014	CN.235M-10	T.19B-02/35-61	29.12.1989
034	CN.235M-100	T.19B-03/35-21	27.2.1991
035	CN.235M-100	T.19B-04/35-22	21.2.1991
036	CN.235M-100	T.19B-05/35-23	1.2.1991
037	CN.235M-100	T.19B-06/35-24	22.2.1991
038	CN.235M-100	T.19B-07/35-25	1.2.1991
039	CN.235M-100	T.19B-08/35-26	25.2.1991
040	CN.235M-100	T.19B-09/35-27	26.2.1991
046	CN.235M-100	T.19B-10/35-28	9.10.1991
047	CN.235M-100	T.19B-11/35-29	9.11.1991
050	CN.235M-100	T.19B-12/35-30	3.12.1991
054	CN.235M-100	T.19B-13/35-31	10.7.1992
059	CN.235M-100	T.19B-14/35-32	10.7.1992
060	CN.235M-100	T.19B-15/35-33	10.7.1992
070	CN.235M-100	T.19B-16/35-34	19.1.1993
074	CN.235M-100	T.19B-17/35-35	
075	CN.235M-100	T.19B-18/35-36	
076	CN.235M-100	T.19B-19/35-37	
079	CN.235M-100	T.19B-20/35-38	

Ecuador							
015	CN.235M-100	AEE-502	(reported)	077	CN.235M-100	077	
016	CN.235M-100	AEE-503	18.4.1989	080	CN.235M-100	080	
017	CN.235M-100	ANE-204	8.5.1989	083	CN.235M-100	083	
				086	CN.235M-100	086	
				089	CN.235M-100	089	
				091	CN.235M-100	091	
				093	CN.235M-100	093	
Chile				095	CN.235M-100	095	
020	CN.235M-100	E-216	31.7.1989	097	CN.235M-100	097	
021	CN.235M-100	E-217	13.8.1989	099	CN.235M-100	099	
022	CN.235M-100	E-218	(w/o 25.2.1992)	101	CN.235M-100	101	
			5.10.1989	103	CN.235M-100	103	
				104	CN.235M-100	104	
Morocco				106	CN.235M-100	106	
023	CN.235M-100	CNA-MA	27.9.1990	108	CN.235M-100	108	
024	CN.235M-100	CNA-MB	27.9.1990	111	CN.235M-100	111	
025	CN.235M-100	CNA-MC	27.9.1990	113	CN.235M-100	113	
026	CN.235M-100	CNA-MD	19.10.1990	114	CN.235M-100	114	
027	CN.235M-100	CNA-ME	4.10.1990	117	CN.235M-100	117	
028	CN.235M-100	CNA-MF	29.11.1990	119	CN.235M-100	119	
031	CN.235M-100	CNA-MG					
South Africa (Bophutswana)							
001	CN.235-1	T-330	9.1.1991				
France							
043	CN.235M-100	43/62-IA (ex 330-ID, CEAM)	28.2.91				
045	CN.235M-100	45/62-IB (ex 330-IB, CEAM)	28.2.91				
065	CN.235M-100	65/62-IC (ex 330-IF, CEAM)	1.1993				
066	CN.235M-100	45/62-ID (ex 330-IG, CEAM)	1.1993				
071	CN.235M-100	45/62-IE (ex 330-IH, CEAM)	9.1993				
072	CN.235M-100	45/62-IF (ex 330-II, CEAM)	9.1993				
Gabon							
044	CN.235M-100	TR-KJE	19.3.91				
(?)	CN.235M-100	TR-KJF (?)	26.2.1991 (reported)				
Ireland							
019	CN.235M-100	250	6.6.91				
085	CN.235M-100 MP	252	(returned 16.1.1995)	8.12.1994			
094	CN.235M-100 MP	253		8.12.1994			
Indonesia							
016N	CN.235M-10	A-2301 (AX-2301)	11.1991				
017N	CN.235M-10	A-2302 (AX-2302)					
022N	CN.235M-10	A-2303 (AX-2303)					
023N	CN.235M-10	A-2304 (AX-2304)					
024N	CN.235M-10	A-2305 (AX-2305)					
025N	CN.235M-10	A-2306 (AX-2306)					
Papua New Guinea							
48	CN.235M-100	P2-0501	15.11.1991				
49	CN.235M-100	P2-0502	15.11.1991				
Turkey							
051	CN.235M-100	051	25.1.1992				
052	CN.235M-100	052	25.1.1992				
055	CN.235M-100	055	20.10.1992				
056	CN.235M-100	056	.1992				
057	CN.235M-100	057	4.1993				
058	CN.235M-100	058	30.6.1993				
061	CN.235M-100	061	14.8.1993				
064	CN.235M-100	064	9.1993				
067	CN.235M-100	067	9.1993				
068	CN.235M-100	068	10.1993				
069	CN.235M-100	069	11.1993				
073	CN.235M-100	073					
Oman							
062	CN.235M-100	A40-CU	14.1.1993				
063	CN.235M-100	A40-CV	14.1.1993				
South Korea							
078	CN.235M-100	078	13.11.1993				
081	CN.235M-100	081	14.11.1993				
082	CN.235M-100	082	15.12.1993				
084	CN.235M-100	084	15.12.1993				
087	CN.235M-100	087	12.1.1994				
088	CN.235M-100	088	12.1.1994				
090	CN.235M-100	090	5.2.1994				
092	CN.235M-100	092	5.2.1994				
096	CN.235M-100	096	20.2.1994				
098	CN.235M-100	098	20.2.1994				
100	CN.235M-100	100					
102	CN.235M-100	102					
United Arab Emirates/Abu Dhabi							
019N	CN.235M-10						
026N	CN.235M-100	810					31.8.1993
027N	CN.235M-100	811					
028N	CN.235M-100	812					15.12.1993
029N	CN.235M-100	813					
030N	CN.235M-100	814					
031N	CN.235M-100	815					
Development aircraft							
P1/01	CN.235-1/-10/-100/-10MP						
01N	CN.235-1/CN.235-10/-10MPA						
							EC-100 (ff 11.11.1983)
							PK-XNC (ff 30.12.1983)
c/n 015 and 053 were not completed.							



Akhtubinsk Test Centre

Photography by Yefim Gordon



Above: A pair of Su-27s approaches the An-12 camera ship with the Volga river below. Akhtubinsk operates a squadron of 'Flankers'.

Left: Another squadron flies the 'Fencer'. Armament trials figure prominently in the Su-24's tasks at Akhtubinsk.



Despite the funding difficulties and fuel shortages which face military aviation in Russia, the nation maintains a massive research and test programme covering a wide range of subjects. As a result of the establishment of the Mosaero show, and following several visits made by Western journalists, the West's attention to Russian R&D is largely focussed on the sprawling base at Zhukhovskii, home of the LII and sporting the longest runway in Europe. However, the large majority of day-to-day test programmes undertaken by the Russian air force are handled at the remote and highly secure base at Akhtubinsk, way to the south and far from the prying eyes of foreigners.

Right: This battered Tu-134 may be employed for general transport tasks, but the non-standard fairings on the spine suggest its use as a trials aircraft.





Left: Under test at Akhtubinsk is the Su-27IB/Su-34, intended for the air force's long-range interdictor requirement to replace MiG-27s and some Su-24s. An electronic warfare version is reportedly under development.

is restricted. Today Akhtubinsk is the largest of the Russian test centres.

It is also the most secret. Access is highly restricted, and requires the signatures of many high-ranking air force officials, including that of General Deynekin, the chief of the air force. A large area surrounding the site is tightly controlled, an important security consideration as much of the centre's work is performed at low altitude.

Akhtubinsk State Flight Test Centre, known by its Russian acronym of GLITs, has two runways, one of which is almost as long as that at Zhukhovskii. A very large range area surrounds the airfield site, heavily instrumented with telemetry equipment for recording aircraft and weapons performance. The main weapons ranges are in unpopulated areas of neighbouring Kazakhstan, a bilateral agreement existing to cover their use by Russian aircraft. In addition to flying programmes, the centre also houses a wealth of theoretical research studies; in 1994 the combined total was more than 300 separate programmes.

Akhtubinsk's flying tasks cover a wide variety of aircraft, system and weapons tests. By comparison with the US test centres, Akhtubinsk's efforts covers much of the type of service clearance and aircraft systems work undertaken at Edwards, to which can be added the tactical trials of Nellis and the weapons functions of Eglin. The centre is officially a joint civil/military facility, but in reality only military programmes are undertaken.

Akhtubinsk is one of two main flying centres for the NII-VVS (Scientific and Technical Institute of the Russian air force). The NII-VVS was established in 1920 at the airfield of Chakolovskaya, about one hour's train journey east of Moscow. This base still houses the transport and helicopter testing departments of the

The Su-24M 'Fencer-D' is the main VVS strike aircraft, and a squadron is based at Akhtubinsk for a wide variety of tests. Su-24MPs and Su-24MRs also serve at the base.

NII, but all other testing was transferred to Akhtubinsk from 1960, when construction of the new test base was begun. In September 1995 the NII celebrated its 75th anniversary, and some information was released concerning the institute's work.

Akhtubinsk is situated near the Volga river, between the major cities of Volgograd and Astrakhan, and close to the early Soviet missile test site of Kapustin Yar. The region is remote and sparsely populated, and travel for foreigners





Based on the airframe of the Su-25UB trainer, the Su-25TM is the latest combat version of the tried and tested 'Frogfoot'. The TM incorporates a large dorsal hump containing extra avionics and more fuel. The avionic suite allows greater automation for navigation, target acquisition and weapon release, while the widened nose houses a TV sensor. Visible below is the NNPU-8M twin-barrelled 30-mm cannon under the starboard fuselage and offset nosewheel.



Akhtubinsk Test Centre



Above: A pair of Beriev/Ilyushin 'Mainstays' is at Akhtubinsk, believed to be the A-50U upgraded variant with the Vega Shmel-M radar. This includes a passive tracking capability and better processing compared with the original A-50.



Akhtubinsk accommodates a wide variety of aircraft which support the centre's work. Shown above are Let 410s which are used for general purpose transport and survey work, while inflight refuelling tests are accomplished using the Il-78 'Midas' (below).



A large number of aircraft covering virtually all types in service and under development are assigned to Akhtubinsk. Testing of existing types continues, especially with the integration of new weapons and systems, while development work continues on new air force types such as Su-27M (Su-35), Su-27IB (Su-34) and MiG-31M. Reports suggest that the MiG-29M will also resume flight testing at the centre in the near future.

Supporting a wide range of missile and sensor tests is a large fleet of radio-controlled drones. At present the main FSAT (full-scale aerial target) force consists of M-21s (converted MiG-21s) with various MiG-15s and MiG-17s still in use. Previously the Sukhoi Su-9 'Fishpot' was the main type but these have all been expended. MiG-23s are being gathered for future conversion to replace the MiG-21s. At the lower end of the speed spectrum the Aero L-29 Delfin is used as a drone for short-range missile engagements. It is understood that two-seat fighters, such as the MiG-23UB, are used for drone direction.

In addition to the fighter drones, Akhtubinsk has a small fleet of large drones, in the shape of the Tu-16 'Badger'. Four Tu-95 'Bears' are believed to be earmarked for drone conversion. The precise reason for their use is not known, but it is likely that they could be used in support of long-range air-to-air missile projects. The single Tu-95MA 'Bear', previously seen at Zhukhovskii, is now believed to be resident at Akhtubinsk. Equipped with large pylons, this aircraft is believed to be in use for the Raduga ramjet missile tests. Also at Akhtubinsk are two Ilyushin/Beriev A-50 'Mainstays', for continued AWACS system testing.

Transport aircraft provide support for the base, on detachment from the NII facility at



Above: The MiG-29 is usually seen in air defence configuration, but this aircraft carries four underwing pylons for bombs to highlight the type's considerable air-to-ground prowess. The Akhtubinsk squadron is heavily involved in weapons clearance tests for the aircraft. This machine is a Type 9.13 'Fulcrum-C', with the fat-backed spine.

Right: Of around six An-72s usually deployed to Akhtubinsk from the main NII transport test centre at Chakolovskaya is this aircraft in VIP configuration. The An-72 has very pleasant handling and surprising agility, making it a popular choice of transport for those high-ranking officers who like to keep their hand in while travelling between engagements.





Chakolovskaya. These include a single Tu-154 with VIP interior, Tu-134s, five or six An-72s, one of which has a VIP interior, and some Let 410s for utility work.

Large numbers of test pilots are employed at the centre, led by chief pilot Major General Churkin, recently created a Hero of Russia in respect of his long and excellent service as one of the top test pilots in the country. Pilot retention is reportedly a problem owing to the low

salaries and lack of flying hours, problems which face all of the Russian military establishment. Pilots keep simultaneous currency on several types of aircraft, the major types being arranged into separate flying squadrons (MiG-29, Su-24, Su-25 and Su-27).

While Zhukhovskii grabs the limelight, the everyday testing of military equipment continues unabated in tighter secrecy at Akhtubinsk, despite the enormous pressures imposed by

Russia's socio-economic problems. In addition to this vital work, the centre also continues to train test pilots and engineers so that the tasks can proceed for as long as there is fuel and money to fly. **David Donald**

Among the large fleet of radio-controlled drones used for missile tests are a few Aero L-29 Delfins, suitably equipped with radio antennas. On the lower rear fuselage are what appear to be IR signature-enhancing flares.





Above: A row of disassembled Tu-95s stands testament to the success of the US/Russian disarmament treaties. The aircraft are Tu-95K-22 and Tu-95KD-22 (with probe) 'Bear-Gs', the example nearest the camera retaining its wingroot pylon for the Kh-22 missile.

Left: A regular Su-27P poses for the camera. In addition to the first-generation 'Flankers', the Su-27M/Su-35 is also under test at Akhtubinsk.

Right: The blue tail of this ex-Aeroflot Tu-154 signifies its use as a transport. Only one is assigned to the test centre.

Below: These Tu-95MS 'Bear-H' bombers are believed to be destined for drone conversion at Akhtubinsk. In the background is a Tu-16, a type which is presently used as a drone at the test centre.





Northrop F-5

Although it was never built in quite the numbers of the F-4 or F-104, the F-5 set records for its longevity in production and in service, and proved to be one of the most successful export products of the US aircraft industry during the entire post-war period. The aircraft was eventually developed almost out of recognition from the original design, yet retained the same combination of reliability, maintainability, economy and blistering performance. As a result, the aircraft was widely exported, sometimes partly or wholly funded under the terms of the Military Assistance Program, and sometimes simply sold commercially. The F-5 soon appealed to the air arms of a number of advanced nations, including the US Air Force (which took it to war in Vietnam) and the US Navy and Marine Corps, who still use it in the adversary role.



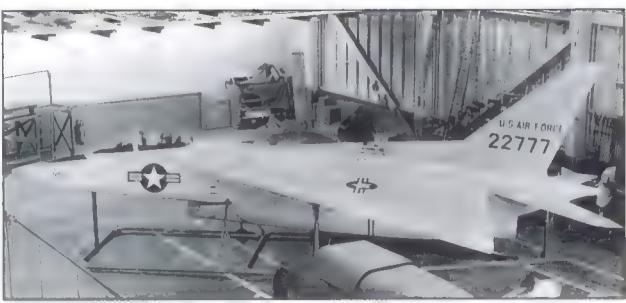
An overhead view of a Chilean F-5E shows the aircraft's configuration to advantage, with its tapering, modestly swept wing, area-ruled fuselage and the enlarged wing-leading-edge extensions which characterised the F-5E. This aircraft carries a dummy AIM-9 on the port wingtip launch rail.

Northrop F-5



Above: Shortly after being shipped to Edwards AFB (but still unfloated) the first N-156F is seen in company with the first two YT-38 Talons. Northrop's J.D. Wells and Hank Chouteau are seen with Captains Swart Nelson and Norvin Evans, respective USAF project pilots for the T-38 and N-156F.

Right: The N-102 Fang never progressed beyond the mock-up stage, its reliance on a conventional, available turbojet engine having made it too big and too heavy for Ed Schmued's ultra-lightweight aspirations. Nevertheless, the Fang was the first tangible evidence to emerge from the series of studies which eventually culminated in the N-156F.



Front-line pilots flying the world's most capable fighters have been humbled by an older, cheaper and more primitive aircraft. The F-5 was developed as a lightweight fighter for use by nations too poor to afford the latest hardware, or too unstable to be trusted with it. Its combination of performance and economy proved powerful, however, and the aircraft was refined and improved and widely exported.

In the face of a growing global Cold War threat, many Free World nations felt that they faced a stark choice – defend or succumb. While the USAF and other major protagonists were able to re-equip with increasingly expensive and sophisticated super fighters, many other nations needed more reasonably priced combat aircraft, which they could afford to operate and which they could deploy in large numbers. Many nations also needed something less sophisticated than the latest 'Century Series' superfighters and more within the capabilities of their ground crew to maintain and service, and which could operate from less

Bedecked with Dayglo and with its nose painted to resemble an enormous radome, the N-156F gets airborne from Edwards during an early test flight. At this stage of its career, the first prototype still carried a massive test instrumentation boom.



lavishly equipped airfields. Many also wanted a fighter which would rely less on a vulnerable, predictable logistics network, susceptible to enemy air attack. The Dutch had found that the transition from the F-84G to the F-84F had required 25 per cent more skilled manpower, which could only be funded by decreasing operational readiness in other ways. The introduction of larger, heavier, more sophisticated aircraft – with its attendant problems – would have caused an even greater impact and, while advanced nations like the Netherlands could cope, others could not. Even nations that could cope with more sophisticated fighters did not want to, since the inevitable result of procuring such aircraft was that numbers would have to fall, at a time when numerical strength was vital.

Northrop might at first seem to have been unlikely converts to the lightweight fighter concept. The wartime P-61 had been one of the largest, heaviest, most sophisticated and most expensive fighters of the conflict, while in its day the post-war F-89 had also been the USAF's biggest and most expensive fighter. But by the 1950s, Northrop was looking for innovative solutions, not least at the urging of its new Vice President in charge of Engineering, Edgar Schmued, a recruit from North American who had played a pivotal role in the development of the P-51 – a lightweight fighter by wartime US standards.

Northrop launched various studies to examine what kind of fighter the Free World actually needed, despatching a team of engineers and analysts to a number of European and Asian nations allied to the USA. Northrop's studies broke down overall programme cost into R&D, procurement and operating costs, and showed that the latter represented the highest proportion. It followed that reducing operating costs was the best way of producing an affordable fighter. In turn, Northrop correctly deduced that operating costs were directly proportional to size, weight and complexity, and set about designing a lightweight fighter, the N-102.

Reliance on powerplants in the class of the General Electric J79, Pratt & Whitney J57 and Wright J65 ensured that the N-102 (later named Fang) would never be a true lightweight, and all-up weight (AUW) remained between 15,000 and 18,000 lb (6800 and 8165 kg). By comparison, the British Folland Gnat was very light, weighing in at about 8,200 lb (3720 kg) fully laden. A mock-up of the Fang was produced by 1954, but the design had escalated in weight and cost, and Tom Jones, then Northrop's Planning Officer, pressed for cancellation in favour of a lighter, cheaper aircraft.

From Fang to Freedom Fighter

Design of such a fighter began in 1955, using the series designation N-156. The availability of General Electric's miniature J85 made possible the development of a smaller, lighter aircraft. The original YJ85-1 was a non-afterburning turbojet rated at 2,100 lb st (9.34 kN) and intended for missile and drone applications, including the GAM-72 Quail. General Electric promised an afterburning J85-5 rated at 3,850 lb st (17.13 kN), and Northrop sketched its new lightweight fighter designs around this engine.

The N-156 went through various incarnations, with the configuration changing quite dramatically. The 1954 N-156TX 'Tally Ho' fighter used two of the engines in underwing pods, and had a crew of two under a shallow tandem canopy. The N-156NN was a naval fighter, with a configuration similar to that of the Grumman F9F and optimised for use from the US Navy's escort carriers and similar sized ships like the British 'Majestics'. The premature mothballing of the US Navy carriers effectively killed off the N-156NN. By 1956 the aircraft had a folding ventral fin and a booster rocket, but the designers did reject plans for a very low-drag shallow canopy and Fairey FD.2-style drooping nose. The final design chosen for aerodynamic wind tunnel testing was tested in two closely related forms: the single-seat N-156F and the two-seat N-156T.



The J85 engines were installed side-by-side in the rear fuselage, hanging from rails. They could be accessed and removed by taking off the lower part of the rear fuselage (complete with the horizontal tail). The two engines were so light (at 585 lb/265 kg each) that they could actually be removed and refitted using manpower alone, without hoists. Each engine had a thrust ratio of more than seven to one. During a demonstration tour in Saudi Arabia, a four-man team (two of them lightly-built press-ganged locals in traditional dress, with turbans and sandals) undertook an emergency engine change at night, without hoists or special tools, resulting in a remarkable series of publicity photos. Engines could be removed without disturbing accessories and accessory drives.

The aircraft was designed for a maximum speed of Mach 1.5, leading it to be referred to as a 'slow fighter'. Northrop could, they said, have squeezed 0.3 Mach more from the airframe, but chose instead to concentrate on reliability, maintainability and running costs. The final 5 per cent increment in performance typically cost 50 per cent of development costs, according to Northrop studies, and they decided to save those costs. This was a brave decision, and something of a gamble, since much of the resistance to the N-156F stemmed from the fact that it was slower, in absolute performance terms, than many of the threat aircraft it might have to face.

A wealth of ability

The relatively low performance of the N-156F inferred the use of fairly sophisticated guided weapons in the air-to-air role, since it would be unable to close to very short distances. It really needed to be able to engage and destroy an enemy bomber head-on, at the maximum possible range. The N-156F therefore was sketched with five different fire control systems, since Northrop initially felt that this was an area in which different customers would have widely differing requirements and expectations. While the mock-up had a small rounded radome, the radarless prototype had its nose painted to represent various sizes of radome at various times. By 1960, Northrop was even offering what it called the Rapiere system, combining a Hughes Taran fire control system (as used in the F-101B) and Nord AS20 or AS30 missiles (or their proposed air-to-air derivative, the AA25), which were claimed to give all-weather forward hemisphere attack capability. These weapons would have been no easier to use in the single-seat F-5 than was the GAM-83, since their radio command guidance relied on the pilot steering them using a miniature control stick on the left-hand console.

In simulations, Northrop compared the N-156F and a generic maximum performance Mach 2+ interceptor, running both aircraft against Mach 0.9 and Mach 1.5 bombers

attacking targets in West Germany. Northrop factored in an identical budget, and aircraft availability, while also taking into account the N-156F's twin-engined reliability and ability to operate from forward airfields. These factors allowed the N-156F to make between 70 per cent and 75 per cent more intercepts than the Mach 2 fighter.

In a compromise, Northrop made plans for the N-156F to be capable of Mach 2 by using an ingenious system of pre-compressor water-injection cooling, which was claimed to double afterburning thrust between Mach 1.5 and Mach 2.2. This was a quite different approach to the direct water injection used in aircraft like the Boeing 707 and KC-135, in which mass flow was crudely increased by dumping large quantities of water through the engine. The system proposed for the N-156F used relatively small quantities of water to cool the compressor by evaporation, thereby increasing efficiency and thrust. The system thus used about half a pound of water per pound of fuel, rather than the 10:1 ratio in the big Boeings. The system would have necessitated a water tank in the spine (increasing weight and reducing fuel capacity) and an associated system of pipework and injectors. It would also have involved the fitting of a sophisticated variable intake ramp, with a further weight penalty. Furthermore, since the F-5A was destined to have a limiting Mach number of 1.72, (or a limiting IAS of 710 kt), some structural strengthening would also have been required.

Ease of operation, ease of maintenance

Northrop's belief in operation from forward airstrips echoed the fashion of the day, as did its emphasis on making provision not only for small JATO-type rockets but also for massive zero-length launch type rockets, to enable the aircraft to be blasted into the air from a fixed or mobile launch ramp. Similarly, the aircraft was fitted with a solid propellant cartridge starter and a 10-litre (38-US gal) LOX system, sufficient for five days of operations (18-20 flying hours), while single-point pressure refuelling allowed a complete turnaround (in intercept configuration) within eight minutes. The starter cartridge could quickly be replaced and was used to start the port engine, bleed air then being used to start the starboard engine. To improve maintainability, Northrop provided a generous 124 access panels, these covering 25 per cent of the aircraft's surface. Pylon attachment points were at waist level, to minimise turnaround times.

The basic shape of the N-156 was unsurprising. The fuselage was pinched in at the wingroot (waisted) following the fashionable Whitcomb theory of managing cross-sectional area distribution to minimise drag, the so-called Area Rule. Many believed that Northrop's slavish adherence to the area rule was the primary factor in the N-156F's performance, and that the same supersonic capability would

Three anonymous-looking F-5As from the USAF's 441st CCTS at Williams AFB fly a neat formation for the camera. Laden with underwing fuel tanks, bombs and centreline napalm tanks, their trainee pilots are in for some fun. The Williams-based F-5s briefly wore unit markings in the shape of a yellow lightning flash, but the turnover of aircraft (which actually belonged to the user nations, despite their USAF insignia) was high.



This F-5A from the 4441st CCTS wears a Tactical Air Command badge on its tail, superimposed on the yellow lightning flash. TAC actually wanted to procure some 200 F-5As for use in Vietnam, but this requirement was frustrated, although it did lead directly to the Skoshi Tiger evaluation. The 4441st actually used aircraft owned by the customer nations whose pilots and groundcrew it trained, although these were painted in full USAF insignia.

otherwise have required much greater thrust in order to overcome transonic drag. The wing had almost equal taper on the leading and trailing edges, and had no dihedral or anhedral. Sweepback at quarter chord was 25°, with the narrow LEX (leading-edge extension) swept at 60°. The sharp leading edge would have given a stall at an angle of attack of between 3 and 4°, but the incorporation of conical camber (equivalent to about 3° of droop) postponed the stall beyond 10° AoA. Leading-edge flaps further delayed the onset of the stall. The wing proved to have very low induced-drag characteristics.

The fuselage was as narrow a cross-section as was possible, and the rocket booster once regarded as essential was dumped in order to allow the engines to be moved closer together. In profile, the fuselage was bent slightly to maximise the view from the cockpit, with a pronounced cambering of the forward fuselage giving what was referred to as a 'Lady's Slipper' profile, with a slightly concave underside.

Flight controls

Primary flight controls were operated by conventional cables and pushrods which controlled the servovalves at the actuating cylinders. These operated at 3,000 psi (20685 kPa). A spring-loaded trim switch was located on the control column for tailplane trimming. Rudder trim and pitch/yaw oscillation damping was provided by a stability augmentation system, running off the utility hydraulic system. Control forces were light enough for this system to be non-essential, and the aircraft remained fully controllable even with the system totally inoperative. The rudder was limited to 6° of travel, except with the gear down, when locks were removed allowing a full 30° of travel at low airspeeds. The tailplane trim changed automatically when airbrakes were extended.

The leading-edge and trailing-edge flaps were electrically actuated by separate motors, with three positions. They were mechanically interconnected to ensure symmetrical operation even if one flap motor failed. For take-off and landing both were fully deployed, while droop alone was used for manoeuvring at speeds below 300 kt (344 mph; 554 km/h). The leading-edge droop was locked slightly extended whenever the landing gear was extended. The pair of airbrakes under the fuselage was hydraulically actuated.

Internally, there were few surprises. The quest to save weight brought machined and chemically milled skins, and

extensive use of sandwich construction. All fuel was carried in fuselage tanks, the wing remaining dry. The tanks were divided into fore and aft groups (known as left and right to reflect the engines they served). Full cross-feed between tanks was provided. The cockpit was typically American, which is to say it was large, roomy and well appointed, with a remarkably good all-round view through the massive canopy. European fighter pilots, used to the cramped confines of a Hunter or Venom, would have felt something approaching agoraphobia. The Northrop ejection seat was cleared for use from ground level and from speeds of 120 kt (138 mph; 222 km/h). It was rocket-assisted and fully automatic, with a canopy breaker in case the automatic canopy jettison failed. Unusually, a special zero-delay lanyard had to be unclipped when climbing through 10,000 ft (3048 m), then reattached when descending back through 10,000 ft.

Onboard systems

Northrop did not provide an emergency ram air turbine, preferring to duplicate the hydraulic and electrical systems. The hydraulic system used tandem jacks, supplied from different engines. If the left-hand engine failed, the utilities would be lost, but most had a manual back-up. The undercarriage, for example, could be manually unlocked and would then extend and lock under the influence of gravity. Braking was available without hydraulics and, while nose-wheel steering would be lost, steering could be accomplished by using differential brake. Autostabilisers and airbrakes were deemed inessential. Either engine windmilling at 9 per cent rpm gave sufficient hydraulic power for the flight controls in emergency, although in normal use the right-hand engine powered the flight control system hydraulics. If you could not get 9 per cent rpm out of at least one engine, then it quite clearly was not your day, and it was time to step out of the aircraft.

Electrical power was supplied by two independent air-cooled AC generators. These produced 8 kVA, 115/200 volt, three-phase (320-480 cycle) power at 6,400-9,600 rpm. Each generator supplied half the aircraft's power requirement, but in emergency could assume the full load. A transformer in the AC system supplied power to the 28-volt DC system, which incorporated a 28-volt, 11 ampere-hour NiCd battery. The DC system provided power for engine ignition, the intercom, fuel valves, auxiliary cockpit lighting and the turn-and-slip indicator.

The wingtips incorporated launch rails originally intended for Sidewinder, Falcon or Sparrow missiles. The mock-up carried generic dummy missiles which did not resemble any of the likely contenders. By the time the prototype took shape, Sidewinders were on the wingtips.

In November 1955 Welko Gasisch, head of preliminary design, was told to concentrate on the two-seater as this seemed to have the greatest chance of finding a customer. The N-156T was therefore quickly developed to fulfil the

The Imperial Iranian Air Force was the first F-5 customer to stand-up an operational frontline squadron, achieving this milestone in June 1965. This aircraft is seen about two years later, by which time IIAF F-5s had lost their USAF-style buzz numbers and had gained squadron badges on their tailfins.





USAF's 1955 General Operational Requirement SS-240L for a supersonic basic trainer to replace the T-33. The aircraft was selected for purchase (subject to successful flight testing) in June 1956, and the USAF authorised the construction of three prototypes under the designation YT-38, the third to be a static test airframe.

Development of the N-156F fighter was not abandoned, and was resumed at full speed once the T-38 was underway. The work carried out (at USAF expense) was an invaluable windfall for the N-156F team, who soon had access to reams of wind-tunnel data and expected to benefit from flight test results. The first flight of the T-38 was severely delayed by the continuing non-availability of the afterburning version of the J85 engine, whose development had proved far more troublesome than had ever been anticipated. An ultimatum from the USAF demanding that GE and Northrop fly the prototype or forget the J85 programme altogether led to installation of non-afterburning YJ85-1s rated at only 1,900 lb st (8.45 kN). The under-powered YT-38 made its maiden flight on 10 April 1959, and exceeded Mach 1 in a shallow dive five days later.

Although the aircraft could, in theory, have accepted Pratt & Whitney J60 (JT-12) or Rolls-Royce RB145 or RB153 engines, the prototype N-156F was fitted with non-afterburning YJ85-1s, although the thrust had been increased by comparison with the engines used in the YT-38s.

N-156F go-ahead

The N-156F retained maximum commonality with the T-38, and the T-38 mock-up was rapidly rebuilt to serve as the fighter mock-up, even retaining the same spurious serial number. The aircraft was still a private venture and Northrop was gambling with its own money, so it was important to limit changes as far as was possible. There were some alterations, however. The N-156F had a larger intake in anticipation of more powerful engines with greater mass flow. It also featured a square-shaped intake splitter plate, with a perforated section just inside the intake to bleed away any remaining boundary layer airflow. The N-156F introduced extended wing leading-edge roots, leading-edge flaps and a drag chute fairing.

The DoD authorised and funded the construction of three prototypes on 25 February 1958, under the FX programme, which aimed to produce a counter-air fighter for supply to MAP customers. Some \$50 million was provided to Northrop and General Electric for the N-156F. Northrop's share was \$32 million. Northrop had already intended to fund a single prototype, so this was a welcome injection of cash for the project. The aircraft was quickly dubbed 'Freedom Fighter', and a patent was applied for on 24 February 1959. Granted on 8 March 1960, this



Above: Two Skoshi Tiger F-5Cs refuel from a KC-135 en route to Vietnam. The 12 F-5Cs equipped the 4503rd TFS, which flew from Bien Hoa and Da Nang during the evaluation.

Left: One of the Skoshi Tiger F-5Cs drops its maximum bombload of four 1,000-lb (454-kg) bombs on a jungle target. Centrefire tanks were carried routinely.

described Design 187,405 as an 'Airplane' and listed Welko E. Gasisch of Pacific Palisades, George Gluyas of Garden Grove, Arthur Ogness of Rolling Hills and Leon Begin Junior of Pasadena as assignors to the Northrop Corp.

The N-156F was rolled out on 31 May 1959 and shipped to Edwards AFB, where it made its maiden flight on 30 July 1959 in the capable hands of Lew Nelson, four months after the first flight of the YT-38. Nelson took the Dayglo-splashed silver aircraft through the sound barrier on that first flight, despite the lack of afterburning, and afterwards commented that it had "performed like a well-educated lady throughout the entire test." This was due in no small measure to the T-38, the extensive wind tunnel testing, and some unsung work by NASA's variable-stability F-86 Sabre. Even before the first flight, Northrop had predicted a maintenance figure of 21 hours per flying hour (21 MMH/FH) and regarded this as a key selling point. Two 'Century Series' rivals, ('Airplane X and Airplane Y'), had MMH/FH figures of 46 and 43 according to official

Despite its flimsy-looking undercarriage, the F-5's performance from semi-prepared dirt strips was impressive. This early F-5A is fitted with a test instrumentation boom and carries 1,000-lb bombs underwing for rough runway trials. Before the nosewheel lifted it could cause problems by throwing up debris towards the intakes, although instances of foreign object damage were rare.



The CF-5 had a long struggle to gain popularity, arriving on the scene in the wake of an unpopular integration of the armed forces, and appearing to be an economically-motivated compromise and a poor alternative to the RCAF's favoured F-4 Phantom. This aircraft was the first CF-5D, and as such was the first Canadian-built Freedom Fighter to make its maiden flight in Canada, the first two single-seat CF-5As having made their first flights from Edwards AFB. The aircraft is seen here with its rear cockpit packed with test equipment. The hated 'Canadian Armed Forces' title was carried on the port side only, with 'Forces Armées Canadiennes' to starboard. The RCAF was justifiably proud of its traditions and independent status, and it took years to live down the trauma of integration.

Like Canada, Spain built its own Freedom Fighters. These received the internal CASA designations SF-5A, SRF-5A and SF-5B for the Spanish-built versions of the F-5A, RF-5A and F-5B respectively. The air force applied its own designations of C.9, CR.9 and CE.9, and then redesignated them as A.9, AR.9 and AE.9 with the switch from fighter (Caza) to attack (Ataque) duties. Today Spain's Freedom Fighters are used only in the lead-in fighter training role, having lost their operational commitments.



figures quoted by Northrop. The USAF helpfully revealed that the F-104 had an MMH/FH figure of 57.5 during 1959. The company quickly completed and flew the second prototype, but suspended work on the third when the USAF decided that planned testing could be achieved with the two aircraft already completed. Meanwhile, it waited for a production decision from the air force.

With the two flying aircraft turning in unprecedented levels of reliability and availability, Northrop completed far more testing than it had expected. The aircraft conducted in-the-field maintenance tests, rough-field operation and operations from an unprepared strip at NAS Pensacola. Weapons flown on the N-156F included GAR-8-1A Sidewinder, Sparrow III and Falcon air-to-air and Bullpup air-to-surface missiles, various bombs, napalm tanks and unguided rockets, podded and unpodded, and even a 2,000-lb (907-kg) 'Special Weapon Shape' on the centreline. With a maximum payload of 6,200 lb (2812 kg), the F-5 could carry a larger warload than the F-100, while it enjoyed a higher speed, better airfield performance and a dramatically lower fuel consumption. In a 30-day contingency operation, it was calculated that a squadron of N-156Fs would use 2.7 million lb (1.225 million kg) of fuel, 1.38 million lb (626000 kg) less than an equivalent F-100 squadron, while employing 42 per cent fewer maintenance personnel. Following the conclusion of the tests in August 1960, the USAF decided that there was no immediate requirement for 'this class of airplane'.

The programme was cancelled. The third N-156F prototype remained uncompleted. Without a USAF stamp of approval the aircraft stood no chance of being selected by potential customers. The N-156F was dead. Or so it seemed.

Interest in the N-156F was revived in 1962. The Kennedy administration announced its desire to 'pay any price' for the maintenance of freedom and the defeat of

Communism, including funding the supply of advanced fighters to its allies. The arguments in favour of the lightweight fighter remained compelling, and there was no doubt that the N-156F was the most successful lightweight fighter to emerge to that point, its supersonic performance and heavy weapon load easily moving Folland's lighter Gnat into second place.

The Freedom Fighter re-born

The USAF remained sceptical about the N-156, preferring stripped-down versions of the F-104G already sold to Japan and several NATO countries. The austere Starfighter, known variously as the F-104-17 or F-104H, was an F-104G without its \$385,000 all-weather fire control system and navigation system (which could be retrofitted). Even without this equipment, at \$550,000 each the F-104-17s were \$100,000 more expensive than the price being quoted by Northrop for the N-156F. Another contender was the Vought F8U Crusader, then still the US Navy's primary fighter. The Department of Defense and its International Security Affairs Agency preferred the N-156F, not least because of its commonality with the T-38 which, it was hoped, would be selected to replace MAP-supplied T-33s.

While the Air Force remained unconvinced by the N-156F, the Army took a closer interest in the aircraft, borrowing the prototype (and painting it in full US Army markings) for evaluation in its fixed-wing close support aircraft trials. The US Army evaluated a pair of Fiat G91s, the A-4D-2N Skyhawk and the N-156F in a series of comparative trials held mainly at Edwards AFB. The Army was extremely impressed by the N-156F, both its air-to-ground capabilities and its maintainability and readiness. The USAF jealously guarded its status as provider of close air support and operator of jet fighters, and applied pressure for the Army's competition to be abandoned.

The Army went on to use helicopters in the fire support role, but USAF interest in the N-156F had been reawakened and the type was re-examined. US Air Force selection of the N-156F to meet the FX requirement was formally approved by the Secretary of Defense on 23 April 1962, and resulted in an immediate flurry of interest, much of which translated into orders. The designation F-5 was allocated on 9 August. A \$20 million fixed-price contract was signed in October 1962, initiating production. This called for a mix of single-seat F-5As and two-seat F-5B operational trainers, in a ratio of 9:1. The inclusion of two-seat trainers (despite the availability of the very similar T-38) reflected a desire to provide a dual-control aircraft with the closest possible handling characteristics to those of the single-seater, and with the fullest possible operational capability.

The third N-156F was completed to the production configuration under the designation YF-5A, powered by a pair of 4,080-lb st (18.15-kN) afterburning J85-GE-13 engines. Most importantly, it had a strengthened wing to allow the fitting of an extra pair of hardpoints (bringing the



total to seven, including the wingtips), and also had a strengthened undercarriage. The YF-5A flew for the first time in May 1963. The first two N-156Fs were soon brought up to the same standard, making them effectively equivalent to the YF-5A and of considerably greater usefulness in the flight test programme. With the flight test programme well under way a second contract followed on 27 August 1963, bringing the total number of aircraft (including two-seat trainers) to 170.

In mid-1964 the Secretary of Defense directed a revision of the Specific Operational Requirement 199 requiring the addition of two internal 20-mm cannon and compatibility for a fuel tank or camera fit in the nose. This imposed a delay of four months (while the cannon fit was designed and incorporated) and resulted in Category II and Category III testing being conducted virtually simultaneously, between February and October 1964.

The two Colt-Browning M39 20-mm cannon were fitted in the top decking of the nose, immediately ahead of the cockpit. This position made aiming easy and reduced harmonisation problems, but was not without problems. When fired, the guns generated clouds of smoke which streamed back over the canopy and inevitably seeped into the cockpit, while the noise and vibration were reportedly fearsome. The addition of small retractable gas deflectors in front of the barrels helped prevent gas ingestion by the engines but did little to improve the cockpit environment during firing. The deflectors took the form of small blocks, with a hole in the middle through which the shells would pass.

Norway announced its order for F-5As on 28 February 1964, part-funding the 64 aircraft (three squadrons of 20, with four attrition replacements) by replacement of one of the planned squadrons of F-104Gs. These aircraft, designated F-5A(G) by Northrop, incorporated various changes. Since they were expected to operate from primitive forward airfields, and inside the Arctic Circle, the F-5A(G) was given a heated windscreen, an airfield arrester hook and provision for JATO.

The first F-5A was accepted by the USAF during January 1964, but this lacked nose cannon and the type did not enter service until August 1964, with the 4441st Combat Crew Training School at Williams AFB. The initial flyaway cost of the F-5A was \$756,000, with \$578,000 of this for the airframe, \$155,000 for the installed engines, \$11,000 for electronics, \$2,700 for ordnance and \$9,300 for armament.

The first twin-sticker

The two-seat F-5B combined the tandem two-seat cockpit of the T-38 with the airframe of the F-5A, retaining the single-seater's underwing hardpoints, wing leading-edge extensions and flaps, and bigger engine intakes. Only the two 20-mm cannon were missing. A separate windscreen would shield the backseater if the front canopy was lost or jettisoned. The F-5B prototype made its maiden flight on 24 February 1964, but the first was accepted by the USAF within a month and the type entered service on 30 April 1964. On that day, former World War II ace Major General John C. Meyer, Commander of the 12th Air Force, instituted TAC's F-5 training programme with the 4441st CCTS, which was soon equipped with seven single-seat F-5As and five two-seat F-5Bs.

Although it was a USAF unit, the role of the 4441st CCTS was to train pilots and ground crew from customer nations. The basic aim was to train six pilots, two maintenance officers and 50 enlisted men as instructors, for them to act as a nucleus on return to their own countries. The standard course lasted 45 days, and included 182 hours of ground school, including 115 hours of classroom instruction and 50 hours of one-to-one briefing and critique. To this was added 40 flying hours in 38 sorties, including 25 hours in the single-seat F-5A. The common core language used was English, and a 15-week language indoctrination



course was offered to students not sufficiently fluent to commence training. The first class assembled in September 1964 and consisted of six Iranians, four Koreans and two American MAAG (Military Assistance Advisory Group) pilots. The MAAG pilots would be responsible for helping MAP customers integrate their new F-5s, and would assist in setting up their own training programmes. The first students completed training in March 1965. The aircraft flown by the 4441st wore USAF insignia and serials, but were actually MAP aircraft owned by the nations whose pilots were undergoing training. Despite their newness, the 4441st CCTS's F-5s proved remarkably reliable. Availability averaged 80 per cent, and maintenance man hours per flying hour averaged 23 hours initially, settling to 21.

The first operational F-5 squadron was an Iranian unit based at the First Fighter Base at Tehran-Mehrabad. This was declared combat ready in June 1965. Greek F-5As were declared operational with 341 Mira in July 1965, while the first Norwegian aircraft were declared operational the same month. The first Korean F-5A squadron, the 10th FS of the Suwon-based 10th FW, was declared combat-ready on 1 September 1965.

Skoshi Tiger – the Freedom Fighter at war

In an astonishing volte face, TAC had actually requested at least 200 F-5s for use in Vietnam (confusingly, these aircraft were to be known as F-5Cs like the Skoshi Tiger aircraft (see below), but had significant further improvements including a more modern lead-computing gunsight, but probably not radar). This request came as a result of

Three Norwegian F-5A(G)s and a single F-5B(G) are seen on a pre-delivery test flight. Norwegian F-5s had provision for the attachment of JATO bottles, arrester hooks and windscreens de-icing. After their replacement by the F-16, a squadron of F-5s was retained for Europeanisation and lead-in training, and these aircraft have recently been upgraded and modernised by Sierra Technologies.

Northrop F-5



Above: The RF-5A (and the Spanish licence-built SRF-5A as seen here) featured a new nose containing up to four 70-mm cameras, but retained the fighter's cannon. Today the RF-5A remains in service in a number of countries, but most have been stripped of their cameras and fly in the ground attack or training roles. Single examples may remain active in the recce role in Venezuela and Morocco, and a whole squadron is used for reconnaissance duties in Turkey.

Top: A Norwegian F-5A(G) cruises high over the fjords. The Norwegian aircraft were repainted light grey during the 1980s, as part of a limited modernisation and corrosion-proofing exercise.

heavier-than-anticipated attrition in that theatre, and because the F-5 was available with a relatively short lead time. The request was turned down, but a USAF request for a combat evaluation in Southeast Asia was approved by the DoD in July 1965 and the evaluation was initiated on 26 July 1965.

The programme was dubbed Skoshi Tiger, a corruption of 'Sukoshi Tiger' (Japanese for 'Little Tiger'). Five F-5A-15s from FY 1963 and seven F-5A-20s from FY 1964 were transferred from MAP batches and were purchased for use by the USAF. The 4503rd Tactical Fighter Squadron (Provisional) was formed on 29 July 1965 to conduct the evaluation, and its volunteer pilots underwent training and indoctrination with the 4441st co-located at Williams AFB from 2 August, while Northrop modified the selected aircraft. For the evaluation the aircraft received 90 kg (198 lb) of belly armour, jettisonable underwing pylons and provision for the attachment of inflight-refuelling probes on the port side of the nose. Instruments and flight controls were also modified, and the standard Norsight fixed optical sight was replaced by a lead-computing gunsight. The rudder travel limiter was removed. Finally, the aircraft were camouflaged in tan and two-tone green, with light grey undersides. With the modifications incorporated, the aircraft were known as F-5Cs, and were later dubbed 'Tiger Is' in-theatre.

The pilots of the 4503rd TFS were augmented by a 32-man evaluation team consisting of 11 USAF officers, 13

enlisted personnel and eight civilians from the USAF's civilian staff, Rand and Data Dynamics. The only member of the evaluation team to fly with the 4503rd was its leader, Lieutenant Colonel Edward R. Johnston. Their task was to compare F-5 data with data relating to Vietnam combat operations conducted by the F-4, F-100 and F-104.

Deployment to Southeast Asia

The 12 F-5Cs were delivered to the unit on 11 October and left Williams AFB on 20 October 1965 to fly across the Pacific, shepherded by KC-135s and stopping at Hickam and Anderson AFBs. They arrived at Bien Hoa at noon on 23 October, were turned around and flew their first combat mission the same afternoon. The aircraft flew close support, interdiction, armed recce and MiG CAP missions during the evaluation, as well as providing defence suppression for Ranch Hand defoliation missions and escort for Elint and EW aircraft. Although a wide variety of ordnance was trialled by the F-5Cs, the standard weapons were Mk 82 500-lb (227-kg) bombs (1,600 dropped) and 750-lb (340-kg) BLU-1/B napalm tanks (1,700 dropped). The aircraft also expended 550,000 rounds of 20-mm ammunition. Other weapons included the 250-lb Mk 81 bomb, the 1,000-lb Mk 83 and the 750-lb M117. Nineteen-round LAU-3/A rocket pods were also carried, and CBU-2A/A cluster bombs. Skoshi Tiger provided the first clearance of the standard USAF MER on the F-5, allowing six Mk 81s to be carried on the centreline. Wingtip fuel tanks were carried as standard, except on MiG CAP and escort sorties when they were replaced by Sidewinder launch rails. Although they could carry between 2,300 and 3,000 lb (1044 and 1360 kg) of weapons, the F-5s usually flew with just two 750-lb bombs, with 50-US gal (190-litre) tip tanks and 150-US gal (568-litre) tanks underwing and on the centreline. This allowed a one-hour loiter in the target area 140 nm (161 miles; 260 km) from base.

The 4503rd moved to Da Nang on 29 December 1965 for the second 31-day (out-country) phase of the evaluation. They were to have flown missions over Laos and North Vietnam, although in fact they never crossed the North Vietnamese border because Phase II coincided with a lull in the offensive against North Vietnamese targets, imposed by HQ. The aircraft did fly more long-distance and extended-endurance in-country missions, however. These missions



usually required inflight refuelling. The aircraft moved back to Bien Hoa on 1 February 1966 for the final 'surge' phase of the evaluation, limited only by aircraft availability. F-5s flew 17 per cent of the USAF's missions in Vietnam during this final phase. The evaluation ended on 19 February. To the intense disappointment of the Skoshi Tiger pilots, the aircraft never encountered an enemy MiG and they were unable to prove the F-5's air-to-air capabilities.

Combat record

The F-5s flew 3,500 sorties, logging more than 4,000 hours of combat time (or 2,659 sorties and over 2,500 combat flying hours according to some sources). Such was the official level of interest in the evaluation that many records simply disappeared, although those which remain paint a picture of great success. Availability averaged 96 per cent, while utilisation averaged 62.5 hours per aircraft per

month and the maintenance man hours per flying hour figure averaged 11.9 during the initial phase of the evaluation, dropping to 6.5 later. These figures were the best recorded by any aircraft flying in Vietnam. Northrop had predicted that 21 maintenance man hours would be required for every flying hour and had been derided for its optimism! An engine change (with functional flight test) was demonstrated within one hour and 55 minutes. The aircraft proved to be an excellent bomb and gunnery platform, and was surprisingly resilient to enemy ground fire, which proved less likely to hit it in any case.

There were a few problems. The take-off roll of an operationally equipped, laden F-5C was felt to be excessive, while range was felt to be inadequate. This prompted Northrop to redouble the efforts to find a more powerful engine, and to develop a 275-US gal (1040-litre) centreline fuel tank. The range problem was exacerbated by the very

A gaggle of KLU NF-5As displays four quite different colour schemes. The original NATO grey/green camouflage gave way to a variety of grey colour schemes during the mid-1980s, bringing the NF-5s into line with the F-16s then beginning to enter service. These four aircraft wear the insignia of the Twenthe-based No. 313 Squadron, the NF-5 conversion and training unit.

This pair of NF-5As is from No. 314 Squadron, whose badge showed a bow and arrow-armed Centaur. Dutch NF-5As were assembled in Canada, using Fokker-built fuselages. They were the first Freedom Fighters with manoeuvre flaps. The NF-5As were progressively upgraded during their service lives, and by the mid-1980s the aircraft had modern RHAWs, chaff/flare dispensers and improved avionics. The retirement of the NF-5As allowed some of them to be exported to Venezuela, Turkey and Greece.



Northrop F-5

Far right: Canada's two-seat Freedom Fighters were designated CF-5D (for 'Dual'). The increasing importance of the CF-5's training role led to something of a shortage of twin-stickers, which was partially alleviated by selling single-seaters to Venezuela and using the money received to pay for a replacement batch of two-seaters, which included this smart 419 Squadron example. The original silver finish with red wingtips and tailplanes was retained by some aircraft well into the 1990s, but other two-seaters received a variety of Aggressor-type camouflage schemes. Some 26 two-seat Freedom Fighters were included in the aircraft modernised and upgraded by Bristol Aerospace, and which are now for sale after rejoining 419 Squadron for only the briefest interval.

Far right: A pair of CF-5As wears the distinctive blue fin band of 434 Squadron, with the unit's Bluenose schooner badge superimposed. Only two of the planned frontline squadrons ever received CF-5s, and these were NATO-dedicated reinforcement units. 434 Squadron also shouldered the CF-5 conversion and continuation training task until the establishment of 419 Squadron in April 1976. The Bluenoses were based at Cold Lake from 1968 until 1982, when they moved to Bagotville to join the Francophone CF-5 unit, 433 Squadron. 433 Squadron re-equipped with CF-188 Hornets in 1987, and 434 disbanded in 1988. 434 Squadron was later resurrected as an EW training unit, equipped with T-33s and Canadair Challengers.

busy traffic conditions at Bien Hoa, which frequently imposed long delays before landing, while missions were often planned with a 15,000-ft (4572-m) transit instead of the more economical 35,000 ft (10668 m) recommended by Northrop. Difficulties were experienced when dropping 750-lb napalm tanks, which sometimes failed to separate cleanly and which struck the underside of the wing, while premature explosion of cannon rounds sometimes caused windscreens damage or gun jamming. Small fragments were usually ingested by the engines when these incidents occurred, resulting in 41 engines being pulled. During the same period only 14 engines were removed for routine scheduled maintenance. One F-5 was lost after being hit by ground fire during Phase I; the pilot ejected from his flaming aircraft, only to die in hospital. The 4503rd lost its provisional status and became the 10th Fighter Commando Squadron in March 1966, receiving a number of replacement and additional aircraft, although sources differ as to exactly how many.

Although the evaluation was a great technical success, it had been politically inspired, conducted only to appease the limited few who believed in the aircraft. The full test results were never even fully analysed. Thus, the Freedom Fighter was not destined to have a long front-line USAF career, and a second request by TAC for F-5s was turned down, with the DoD instructing that the USAF should examine alternatives, specifically the A-7. The 10th Fighter Commando Squadron was never joined by the planned further F-5 squadrons and was soon disbanded, allowing its aircraft to be passed over to the VNAF. Hitherto equipped only with piston-engined aircraft, and with front-line squadrons standardised on the Douglas A-1, the VNAF had been requesting jets for some months. The F-5 and A-37 were allocated to the VNAF as a direct result of this pressure.

A longer training course was designed for the Vietnamese. The combat-seasoned pilots were all converting to the F-5A from the piston-engined Skyraider, and would be expected to start flying operations on their return from the USA. The course lasted 103 days, and included 92 flying hours. The first class (of 33 pilots) began conversion in October 1966. On their return to Vietnam, the 522nd Fighter Squadron took over the aircraft of the USAF's 10th Fighter (Commando) Squadron.

Freedom Fighter for Tac R

Northrop was quick to see the potential of the F-5A as a dual-role tactical fighter and reconnaissance aircraft, and sketched the N-156C with a rapidly replaceable recce nose even before the N-156F had made its maiden flight. Development of a dedicated daylight tactical reconnaissance derivative of the F-5A was finally ordered in October 1963, with a configuration based upon that of the RF-104G. Development was un hurried, however, and the prototype did not make its first flight until May 1968. Four KS-92A cameras were provided, each with an individual light sensor and automatic exposure control and each with a 100-ft (30-m) magazine. These gave forward oblique, trimetrogon and split vertical coverage using 1.5-, 3- and 6-in (3.8-, 7.6- and 15.2-cm) lenses and using shutter speeds between 1/500th and 1/4,000th of a second. All four could be removed, reloaded and replaced within five minutes. The use of different lenses gave six basic camera configurations. The cameras were accessed via the upper surface of the nose which hinged forward. Both cannon were retained, even with the cameras fitted.

The RF-5A was exported to Norway, Greece, Libya, Morocco, Spain, Turkey, and Vietnam, and some Korean F-5As were converted to the same standard in-country. While the RF-5A's camera nose was theoretically replaceable by the standard F-5A nose, the operation took too long for interchangeability to be a realistic option, except on Canadian and Dutch aircraft, whose similar-looking recce nose is believed to have differed in detail.



Northrop realised that many potential customers would look for a new fighter to provide new transferred technologies and employment for their industries, in addition to being a defensive tool for the local air arm. Licence-production was still unusual in the late 1950s and early 1960s, but Northrop showed itself eager to accommodate the industrial needs of its customers, as well as providing a solution to defence requirements.

Production abroad

As early as 1959, Northrop was able to announce that it was discussing licence-production of the aircraft that was then still the N-156F with a consortium including Belgium's SABCA, Italy's Fiat, and Fokker of the Netherlands. Talks were also held in Australia and the UK, where Fairey Aviation considered the possibility of producing RB.145-engined land- and ship-based versions. In the event, it was Lockheed's F-104G Super Starfighter that won the licence-manufacturing contracts in Europe, with production in Italy, Germany, Holland and Belgium, as well as in Canada and Japan.

While several nations were to operate both the F-104 and the F-5, Canada was unique in actually licence-building both aircraft types. During the 1960s and early 1970s Canada underwent a dramatic demilitarisation and started to withdraw from its overseas military commitments. The 1960s saw Canada unilaterally give up its nuclear capability, and its once significant air force presence in Europe continued to dwindle from its peak of 12 Sabre and CF-100 squadrons in four wings to a token force of only three Starfighter squadrons. The separate army, navy and air force were integrated into an all-encompassing Canadian Armed Forces, a move motivated mainly by the potential for cost savings. The whole CF-5 programme reflected the changes facing Canada's armed forces, in that it was very much a compromise, a cheap option entered into somewhat half-heartedly.

The CF-5A for Canada differed from contemporary Northrop-built Freedom Fighters in a number of important respects. The Canadian variant was powered by the J85-CAN-15, a licence-built version of the 4,300-lb st (19.13-kN) J85-GE-15 built by Orenda, which was already building J85 engines for the indigenous CT-114 Tutor trainer. The Dash 15 gave supersonic capability at low level, the F-5A with the 4,080-lb st (18.15-kN) J85-GE-13 having been limited to subsonic performance low down.



Provision was made for a quick-change reconnaissance nose containing three bays for three or four 70-mm Vinten Model 547 cameras. These were usually fitted with 3-in lenses, but 11 different configurations were possible. The rearmost bay could accommodate one or two cameras, depending on configuration. This new nose was known as the CCS-1 (Camera Control System 1) and was externally identical to the reconnaissance nose fitted to the dedicated RF-5A, but may have differed internally to allow more rapid installation.

The inauguration of Pierre Trudeau as Prime Minister in 1968 marked the installation of a Liberal government even less sympathetic to the armed forces than the Conservatives had been. Under it, only 54 of the 118 CF-5s completed by Canadair were scheduled for service, with the rest being

earmarked for storage. The active and stored aircraft were destined to be rotated to equalise flying hours, and the number of CF-5 squadrons was cut from the planned six to only two. Even in service with only two squadrons, the CF-5As had an active service life, with frequent overseas deployments. The Canadians cleared the aircraft to carry a wide range of weapons, including the CRV7 rocket, the British BL755 CBU and the US Mk 20 Rockeye. It became increasingly apparent that the CF-5 would pick up an advanced and lead-in training commitment. Studies were undertaken into the practicality of converting some of the stored CF-5As into two-seat CF-5Ds, but this promised to be prohibitively expensive. The sale to Venezuela of 16 stored CF-5As and four CF-5Ds (two of the latter being newly built) allowed the ex-CAF aircraft to be replaced by





This RF-5A serves with 349 'Kronos' Mira. The squadron has a flight of RF-5As, but these have had their cameras removed and no longer operate in the reconnaissance role. These aircraft are augmented by former Dutch NF-5As and NF-5Bs. This RF-5A wears the basic standard Greek F-5 colour scheme, but many aircraft wear the colour schemes of their previous operators, at least until they get to a major overhaul. Some Greek aircraft have even been seen with their previous national insignia showing through their new paintwork.

a batch of 18 newly-built two-seat CF-5Ds, increasing the proportion of two-seaters in CAF service.

Northrop had apparently not agreed to Canadair's licence-production of the aircraft for resale to other customers, and the sale of CF-5s to the Netherlands in January 1967 was cited when Northrop attempted to sue the Canadian government over the sale of CF-5s to Venezuela some years later. At the time, however, profits from the Dutch deal covered cost escalation of the CAF aircraft.

The NF-5A for Holland was given the internal Canadair designation CL-226 and the first made its maiden flight on 24 March 1969, in the hands of W. Longhurst. The first NF-5B followed on 7 July, flown by S. Grossman. The Dutch aircraft were further improved, and represented the most advanced sub-variant of the original Freedom Fighter family. The aircraft had a strengthened wing structure and was fitted with manoeuvre flaps, with an actuator on the right-hand throttle grip. The Dutch F-5s had the standard Northrop non-computing sight and replaced the Sperry gyro heading and reference system with a Bendix attitude and heading reference system. The NF-5A also added a Canadian Marconi Type 668 Doppler and 703 navigation system with a roller map. Provision was made for larger external fuel tanks and for the use of ejector bomb racks. The aircraft was fitted with a radio altimeter and a new emergency UHF radio.

Northrop had a financial stake in the Spanish company Construcciones Aeronauticas SA (CASA) and this led to a licence-building agreement after Spain selected the F-5A in 1966. The 70 aircraft were split between 19 single-seat F-5As (designated SF-5A to distinguish them from US-built aircraft), 17 RF-5As (SRF-5A) and 34 F-5Bs (SF-5B). The first eight aircraft were supplied in knocked-down form and were merely assembled by CASA, but the remainder were licence-built at Seville and Madrid-Getafe from components supplied by Northrop. The air force applied its own designations of C.9, CR.9 and CE.9. A switch of primary role from fighter to ground attack was accompanied by a change of designation, with the three versions becoming the A.9, AR.9 and AE.9 respectively.

An advanced F-5

The modifications added to Canadian and Dutch F-5As had marked a major improvement, but it was clear that other modifications could release more of the F-5's latent potential, especially in the air-to-air arena. On their arrival

in Norway, the F-5s had been immediately flown against the air force's F-104s and had proved well able to fight their corner. While the F-5 was agile and nippy, it lacked even the most basic tools for air-to-air combat, with no radar and no lead-computing gunsight. Northrop hoped to demonstrate a second-generation F-5, with a larger wing and more powerful engines to increase performance and agility, and with radar and other avionics improvements to enhance operational capability. General Electric had launched a J85 growth programme in 1962, and had tested a larger compressor in 1963. Neither the Secretary of Defense nor the USAF were prepared to endorse Northrop's unsolicited proposal for a more powerful F-5 without demonstration of the advantages which a re-engined F-5 would offer.

Re-engined F-5B-21

Accordingly, the sixth F-5B was leased to General Electric to serve as an engine development testbed. The aircraft was fitted with enlarged intakes and intake ducts and the engine bays themselves were modified, while extra wingroot sections extended wingspan and area. The aircraft was soon fitted with a pair of experimental YJ85-GE-21 engines, and in this form was known as the YF-5B-21. The J85-GE-21 added a ninth compressor stage and used titanium instead of steel blades. It increased peak mass flow from 44 lb (20 kg) per second to 52 lb (24 kg) per second. The new engine conferred a useful increase in thrust, and in January 1969 the USAF requested that it should become the powerplant in late-production F-5As, although Northrop always felt that its most useful application would be as the powerplant of a new, improved F-5 variant. Thus equipped, the YF-5B-21 flew for the first time on 28 March 1969, in the hands of GE pilot John Fritz.

Congress required that the Advanced International Fighter should be selected competitively, and the USAF was told to solicit bids from other interested companies. On 26 February 1970 the USAF asked eight companies for proposals, four of whom (including Northrop) responded during March, each offering a new variant or derivative of an existing production fighter. McDonnell Douglas offered a stripped-down version of the Phantom, Lockheed the CL-1200 Lancer derivative of the Starfighter, and LTV a lightweight Crusader derivative designated V-1000.

The competition took six months, at the end of which the Secretary of Defense approved production of the

Northrop design. The USAF's Chief of Staff John D. Ryan had favoured the V-1000 from an operational point of view, feeling that this would have provided additional insurance against the possible growth of enemy threats. However, the F-5A-21 was not being procured for the USAF, and was felt to be good enough for the USA's Asian allies. Secretary of the Air Force Robert Seamans explained that the aircraft "should provide our Asian allies with a credible self-defence capability, at the lowest cost among the four competitors. Our evaluation shows that the F-5-21 is superior to the MiG-21 over defended territory where friendly radar control is available and that it also has greater combat capability when neither aircraft is radar-controlled. I had to choose the lowest-cost aircraft that would do the job, and the data and analyses of our evaluation demonstrated that the F-5-21 can satisfactorily perform the basic tasks as we set them forth in the RFP." Cynical onlookers observed that six months was a long time to look at four price tags. The decision was bolstered by the fact that the most likely recipients (Vietnam, South Korea, Thailand and Taiwan) were all already F-5A operators.

The F-5A-21 proposed by Northrop (also known as the F-5N) combined the new engine of the YF-5B-21 with a new air-to-air radar, a lead-computing gunsight, and several of the features already flown on later F-5A sub-types. The aircraft was also cleared to carry 275-US gal (1040-litre) tanks on the centreline and underwing, like the NF-5A. The use of the new Dash 21 engine also required the installation of CF-5/NF-5-type louvre doors in the rear fuselage to prevent compressor starvation at low forward speed. From an early stage, the doors in the F-5A-21 (F-5E) were automatically actuated by new pressure sensors.

In the F-5A-21 the manoeuvre flaps were refined, with four possible settings. They were fully retracted, giving a symmetrical aerofoil for supersonic flight, while the trailing edge drooped 8° for cruising flight. The intermediate setting drooped the trailing edge 8° and the leading edge 12° and was used in combat at speeds of up to 550 kt (631 mph; 1016 km/h) or Mach 0.95. Full flaps (24° for the leading edge, 20° for the trailing edge) were used for take-off and landing.

The radar chosen for the F-5A-21 was the Emerson AN/APQ-153, although this was later replaced by the AN/APQ-159(V). The APQ-153 was a lightweight X-band radar with a conventional parabolic dish antenna and a peak output of 60 kW. It provided limited air-to-air search and tracking capabilities, in-range envelope computation for the wingtip Sidewinders and ranging for the guns. Tracking range was 5 miles (8 km) in the gunnery mode, and 10 miles (16 km) in the missile mode. Automatic

acquisition and lock-on was included. The radar generated an in-range signal at 2,700 ft (823 m) and even generated a minimum range signal at 1,000 ft (305 m). Emerson deliberately omitted several features to reduce weight and cost, including angle-tracking, moving target indication, frequency agility, a flat plate antenna and higher power. Some of these features were restored in the APQ-159.

The radar was integrated with a General Electric AN/ASG-29 gyro gunsight, and later with the AN/ASG-31 lead-computing sight. The lead-computing sight was a repackaged version of the sight used in the F-4 and integrated range and range rate information from the radar, air-speed and information from the central air data computer, and turn rate and acceleration from the gyro computer to generate an aiming reference in the HUD.

Airframe changes

To accommodate the new engines the fuselage was lengthened by 15 in (38 cm) and widened by 16 in (40 cm). This allowed the internal fuel tanks to be enlarged, giving an extra 570 lb (258 kg) of fuel. This increased total fuel capacity from 585 US gal (2214 litres) to 671 US gal (2540 litres). The new enlarged tanks were lined with reticulated foam to improve battle damage tolerance. The increase in width also increased overall wingspan (and thus contributed to the increase in wing area, from 170 sq ft/16 m² to 186 sq ft/17 m²). The wingroot leading-edge extensions were refined and enlarged until they represented 4.4 per cent of the total wing area. This resulted in a 38 per cent increase in maximum lift. The combination of LEXes and manoeuvre flaps was intended to allow the new F-5 variant to achieve higher angles of attack, and thus higher lift, with the same drag, or to achieve the same angle of attack with less drag. The aerodynamic improvements ameliorated turn performance

Bottom: The Philippines fleet of 19 F-5As and three F-5Bs dwindled to just four single-seaters and a single two-seater by 1995. One F-5A and the F-5B are painted in matt light grey overall, with high-visibility national insignia, while the others are camouflaged in tan, brown and olive drab, with insignia in black outline form. The badge on the fin is the insignia of the Philippine air force.

Below: The Philippines used the F-5A to equip its sole fighter squadron, and also the Blue Diamonds display team. This aircraft is seen in the earliest Blue Diamonds colour scheme, which was later added to with coloured trim on the tip tanks and with an individual aircraft number on the nose, let into the trailing edge of the arrowhead. The team gave its last performance during the mid-1980s, although aircraft continued to wear the team's colours until they were repainted in camouflage during the early 1990s.



F-5 aerobatic teams

The F-5's nimble handling and high speed have made it a favourite with aerobatic display teams over the years. Today, the 'Turkish Stars' (who can trace their heritage back to the F-5-equipped 'White Swans' of the 1960s and 1970s) and the 'Patrouille Suisse' are the only regularly established F-5 teams. In times past there were many others. These included, Taiwan's 'Thunder Tigers' who swapped their F-86s for F-5As in 1967 and later adopted F-5Es in 1975. For a single year, in 1967, the Greek air force maintained the 'New Hellenic Flame' team, which flew F-5As and could trace its lineage back to the F-86E-equipped 'Hellenic Flame' team, of 1958. Iran's 'Golden Crown' team flew six F-5As which superseded F-84Gs in 1971, and were themselves later replaced by F-5Es, until 1979. The Philippines could boast the F-5A-equipped 'Blue Diamonds', which was established in 1953 with F-86Fs, and flew F-5s from 1968 until the mid-1970s (when the team was disbanded as an austerity measure). South Korea had its own 'Black Eagles' flying F-5As during the late 1960s and early 1970s, while Canada and Holland both had a tradition of F-5 aerobatic teams operated at squadron level, throughout the aircraft's service career.



Fuel system

Unlike the F-5A, which had tip-tanks, the F-5E wing is completely dry. The F-5E has two internal rubber-impregnated, nylon fuel cells, fore and aft, with a total capacity of 671 US gal (2540 litres).

Swiss F-5 operations

In total, Switzerland took delivery of 98 F-5Es and 12 F-5Fs. During peacetime these aircraft are operated from two bases, Dubendorf and Payerne. In time of war, however, Switzerland would call on its reserve/militia personnel to establish up to seven 'emergency' operational units (for the F-5 alone) at dispersed locations around the country. Switzerland maintains a network of 'austere' air bases (much like Sweden) which only become active in time of need. Many of these have hangarage and operational facilities cut deep into the Alps and are thus virtually immune from conventional attack. Swiss F-5s also regularly practise operations from hardened stretches of otherwise regular highways.

F-5E radar

The standard radar fitted to production F-5Es was the Emerson Electric AN/APQ-159 X-band search and track radar, with an effective range of approximately 20 nm (37 km; 23 miles). This is one of the first items to be replaced in the many F-5 upgrades now available. More modern replacement pulse-Doppler radars include the Westinghouse APG-66 (as offered by Northrop Grumman), the Elta 2032 EL/M-2032 (IAI) and the FIAR Grifo F/X Plus.

Northrop F-5E Tiger II Swiss air force 'Patrouille Suisse' Dubendorf AB

Once a renowned Hawker Hunter display team, the 'Patrouille Suisse' swapped its elderly but much-loved Hunters for the sleek F-5E in 1994. Unlike the Hunters, the F-5s have adopted a radically new colour scheme, completely at odds with that worn by Switzerland's regular service F-5Es.

The 'Patrouille Suisse'

More correctly 'La Patrouille Suisse', the Swiss air force national aerobatic display team was founded in 1964. From the beginning, its six-ship formations were flown by Hawker Hunter F.Mk 58As, and pilots were drawn from the Dubendorf-based surveillance wing. For a long time the Hunters wore the standard grey/green camouflage, with grey-underside paint scheme applied to all Swiss Hunters, to allow the display aircraft to be swapped in and out of the regular fleet with ease. As the 'Patrouille Suisse' became the last operational Hunters in Swiss service, the team adopted a brightly-painted red and white underside, reflecting the colours and design of the Swiss flag. When the Hunters were finally replaced by F-5Es, in 1994, this scheme was extended to cover the entire aircraft.

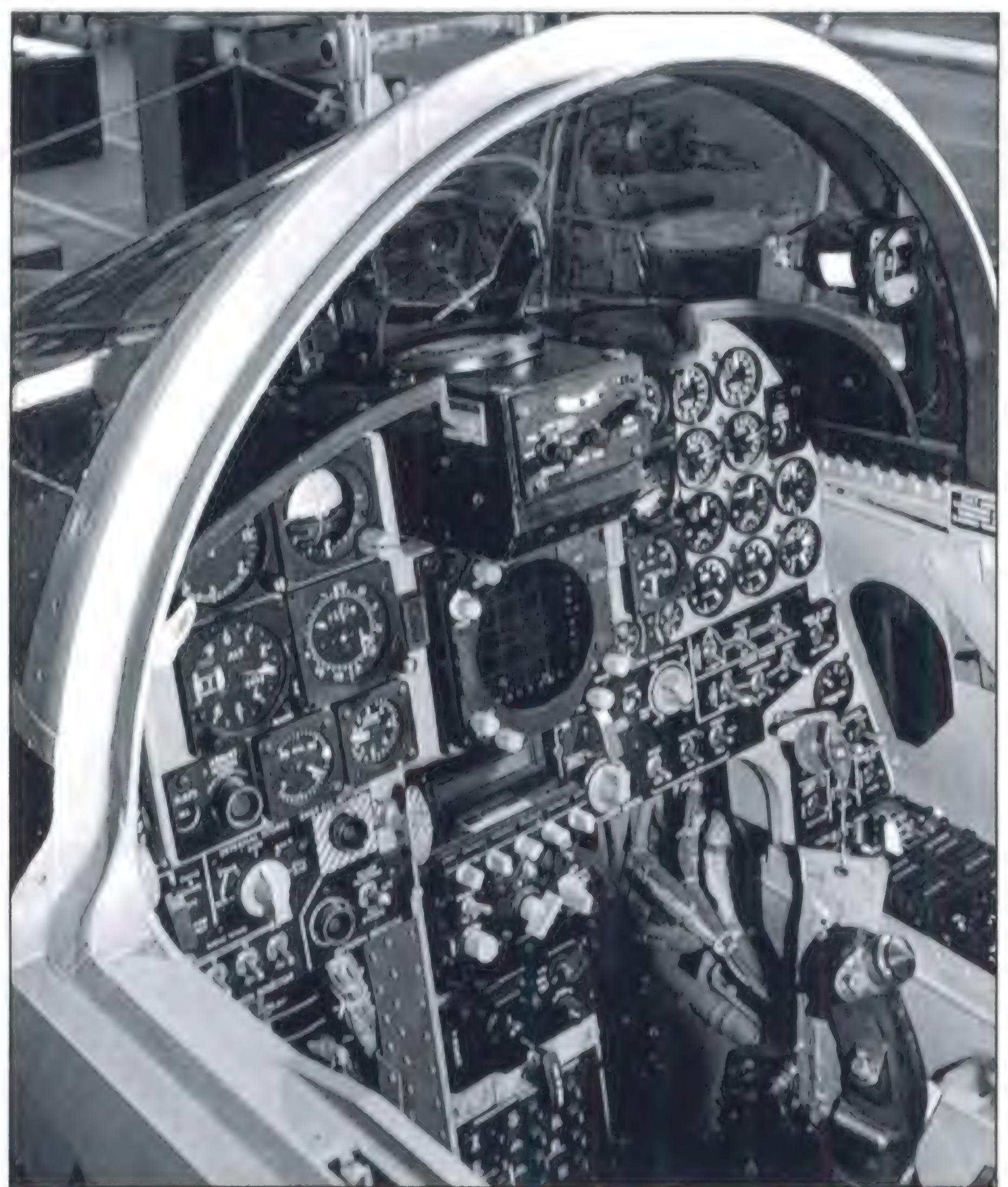


Powerplant

The F-5E relies on two 5,000-lb (22.24-kN) General Electric J85-GE-21A afterburning turbojets, which each have their own separate (though cross-feedable) fuel supplies. Like the F-5A, the F-5E relies on a system of electrically-operated louvre doors (each with six shutters) to supply additional air to the engines during take-off (when they are controlled by the pilot) and in flight (automatically) below Mach 0.4-0.35.



Northrop F-5E Tiger II cockpit



Left: The original F-5E cockpit featured an AN/ASG-29 lead-computing gun sight. Visible below this is the screen for the Emerson Electric AN/APQ-159 radar.

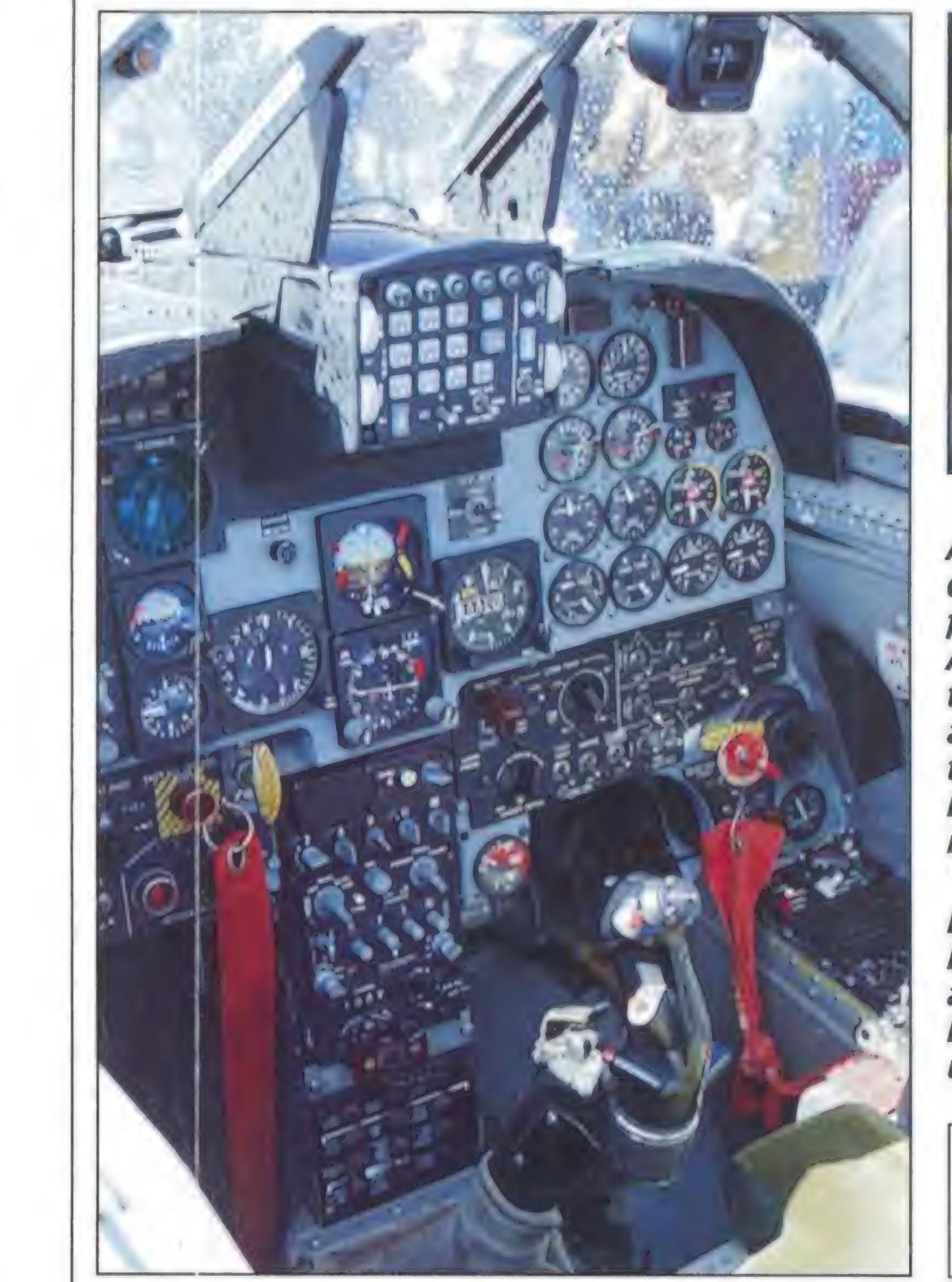
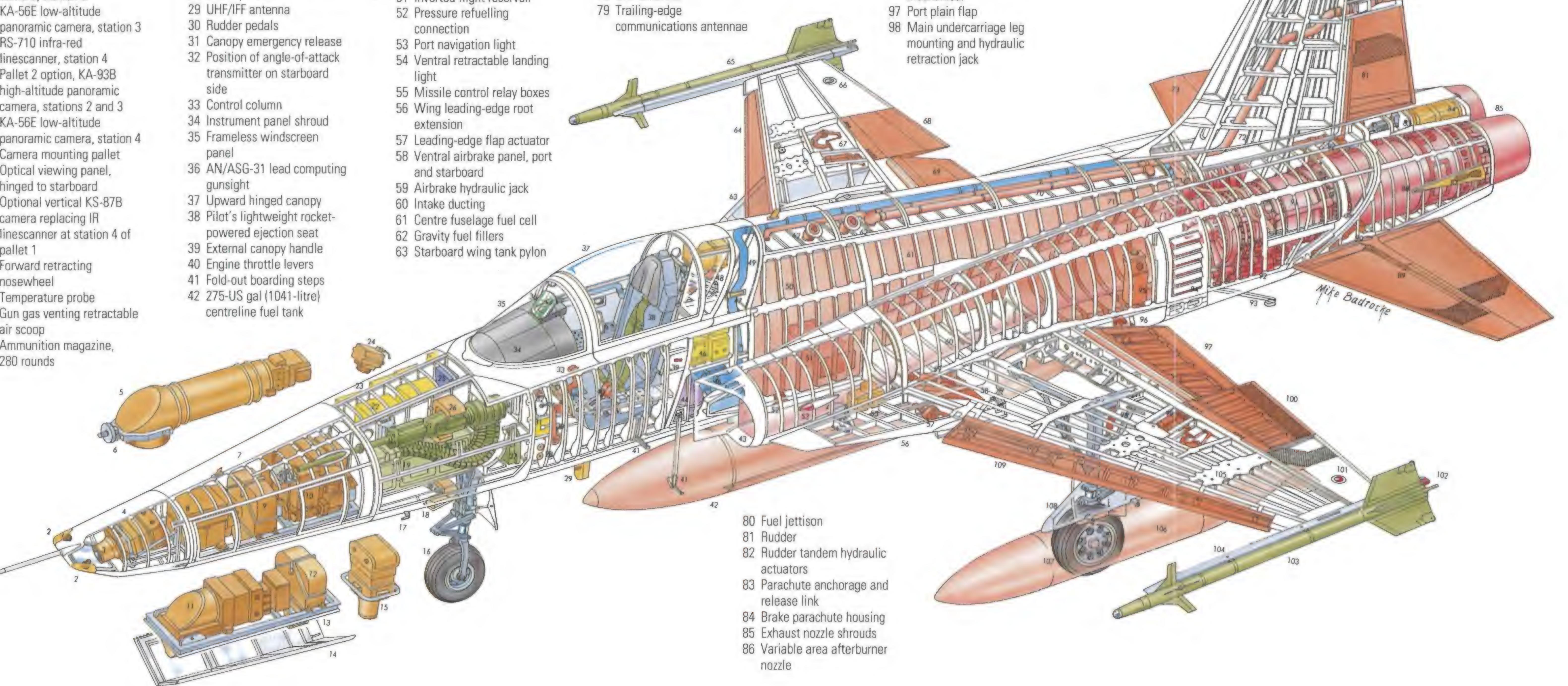


Right: The new-generation Tiger IV cockpit boasts an Allied Signal HUD and air data computer, coupled with a Westinghouse APG-66 pulse-Doppler radar. The cockpit has also been refitted with two colour MFDs and a pair of smaller ancillary colour instrument displays.

Northrop F-5E Tiger IV upgraded cockpit

Northrop RF-5E 'Tigereye'

- 1 Pitot head
- 2 Forward radar warning antennas
- 3 KS-87B forward oblique camera, station 1
- 4 Forward camera compartment
- 5 Pallet 3, HIAC-1 Long-Range Oblique Camera (LOROP), requires reconfigured window aperture panel
- 6 LOROP camera rotary drive
- 7 Main camera compartment
- 8 Pallet 1 option, KA-95B medium-altitude panoramic camera, station 2
- 9 KA-56E low-altitude panoramic camera, station 3
- 10 RS-710 infra-red linescanner, station 4
- 11 Pallet 2 option, KA-93B high-altitude panoramic camera, stations 2 and 3
- 12 KA-56E low-altitude panoramic camera, station 4
- 13 Camera mounting pallet
- 14 Optical viewing panel, hinged to starboard
- 15 Optional vertical KS-87B camera replacing IR linescanner at station 4 of pallet 1
- 16 Forward retracting nosewheel
- 17 Temperature probe
- 18 Gun gas venting retractable air scoop
- 19 Ammunition magazine, 280 rounds



Above: The Samovar jammer has been developed by Norsk Forsvarsteknologi, chiefly for use by the Norwegian air force's Penguin ASH/M-armed F-16s. The pod is also carried by the Tiger-PAWS F-5s, however, which now have a much expanded ECM capability courtesy of their MIL-STD 1553B databus and new GEC-Marconi Avionics air data computer. Samovar is installed inside an old AN/ALQ-184 pod.

Left: Norway's 15 Tiger-PAWS F-5A/Bs have been fitted with a GEC-Marconi HUD/WAC but, apart from the RWR display in the upper left hand corner of the cockpit, remain essentially unchanged from when they were delivered.

Sierra Technologies Tiger-PAWS F-5 upgrade



Bristol Aerospace CF-5 Avionics Upgrade Programme




Top: Even in an AUP aircraft the rear cockpit of a CF-116D remains virtually unchanged. The large screen above the console monitors the HUD display in the forward cockpit.

Above: Just as Bristol Aerospace undertook the required structural work on CF-116s at its Winnipeg plant, it also undertook the airframe/avionics integration. Here a new CF-116 HUD is being calibrated.

Above left: The GEC-Marconi Avionics HUD/WAC for the F-5 (as fitted to this CF-116D) interfaces with the Litton INS installed as part of the CF-116 AUP. It can also display two air-to-ground modes (CCIP and CCRP) and three air-to-air – guns, missiles and a combined dogfight mode.

Left: The new HUD is the dominant feature in the CF-116 AUP cockpit. Note the soft panel to protect the pilot's head.



Badge

The Jambocks' squadron badge consists of a ferocious-looking ostrich, wielding a gun and standing on a cloud, carrying a blue shield on which appears the Southern Cross. This constellation traditionally decorated the centre of the star-type national insignia, though this now features a plain blue disc.

Dorsal fin

Brazil was one of the F-5E customers to take advantage of the optional dorsal fin fillet designed by Northrop, which improved directional stability by providing increased keel area. This provides an immediate recognition feature to distinguish between the F-5Es built for Brazil and the second-hand ex-USAF aircraft delivered later. Most of the latter serve with the 1^o/14^o GAv at Port Canoas. The original Brazilian aircraft also feature the swept ILS blade antenna further forward on the dorsal spine. This was quite common on export versions of the F-5.

LERX

The F-5E featured larger wing leading-edge root extensions than the F-5A. These increased wing area by a significant margin, dramatically improving turn performance. Some upgraded aircraft, including F-5Es in service with the Swiss air force, have further enlarged LERXes based on those fitted to the F-20 Tigershark.

Powerplant

The F-5E is powered by a pair of General Electric J85-GE-21A turbojets, each generating 5,000 lb st (22.24 kN) of thrust with afterburning, at 16,600 rpm. This thrust was available for a maximum continuous period of 5 minutes, or for 15 minutes during a flight. Maximum military power (available for 30 minutes) was 3,500 lb (13.35 kN) thrust, while the normal maximum was 3,280 lb (14.60 kN) thrust at 16,285 rpm. The Dash 21 version of the engine introduced titanium compressor blades (allowing higher operating temperatures while simultaneously reducing weight) and added an extra compressor stage, thereby increasing the overall pressure ratio of the engine. The J85-GE-21 was the first version of the engine to employ variable stators, introducing four stages of these. The engine had a thrust-to-weight ratio of about 7.5:1 and mass flow was increased from about 44 lb (19.96 kg) per second to 52 lb (23.6 kg) per second. Specific fuel consumption was reduced from the F-5A's 1.03 lb/lb/hr to 0.99 lb/lb/hr. The increased thrust of the J85-GE-21 gave improvements in speed, climb, endurance and range, while engine handling and throttle response was also improved. The YJ85-GE-21 was flown in the YF-5B-21 on 28 March 1969, in the hands of General Electric Chief Test Pilot John Fritz, formerly a Northrop test and demonstration pilot. The variable engine nozzles are fully enclosed within fixed jetpipes. The starboard engine was usually fed from the 212-US gal (803-litre) centre fuselage fuel cell and the 169-US gal (640-litre) rear fuselage cell, while the port engine was fed from the 296-US gal (1120-litre) forward fuel cell. A crossfeed system allowed fuel to be fed from any tank to either engine. All fuel cells were rubber-impregnated nylon bag-type tanks. No further improvement has been made to the J85 engine for the F-5, and the small dimensions of the engine make straight replacement by a pair of new engines difficult. The advanced F-5G switched to use of a single F404 turbofan.

Arrester hook

The arrester hook is a single-shot device, intended for emergency use only. It is normally extended hydraulically, but can be unlocked and allowed to drop into position through gravity. It can only be retracted on the ground, and has to be manually stowed before the engines are shut down. Otherwise, fuel venting from the engines on shut down can drop onto the hook (heated by friction) and ignite.



Inflight refuelling probe

The original Brazilian F-5Es are almost inevitably fitted with the detachable inflight refuelling probe under the starboard canopy rail. This allows the aircraft to refuel at rates of up to 2,000 lb (907 kg) per minute. A small spotlight is fitted in the shoulder fairing at the base of the sloping down-pipe, allowing the pilot to illuminate the probe tip and refuelling basket during night refuelling. The external tanks can be refuelled in flight if they are first depressurised. A very similar probe is fitted to Brazilian AMX fighter bombers which are assigned to 1°/16° GAv co-located at Santa Cruz. Both types of aircraft can refuel in flight from Brazil's KC-130H and KC-137 tankers, which are based at nearby Galeão. The use of inflight refuelling allows the aircraft to take off with higher payloads, topping off their tanks when airborne. They are primarily used in the fighter-bomber role. The ex-USAF F-5Es and F-5Fs used by 1°/14° GAv do not carry inflight refuelling probes, and are used primarily in the air defence role, defending Brazil's southern borders.

Fatigue

The F-5 was born at a time when the understanding of metal fatigue and stress corrosion cracking was in its infancy, and when few people expected combat aircraft to have service lives exceeding much more than 2,000 hours. Studies during the 1970s, based on typical and extremes of usage allowed Northrop to calculate the likely life of the airframe, but such estimates were not always reliable, and some components have failed or required replacement long before they had reached the predicted ends of their lives. The result has been a widespread series of F-5 structural modernisation and upgrade programmes, replacing many parts with new components made of more fatigue resistant materials, and incorporating some parts whose lives will far exceed even the most optimistic estimates of F-5 fatigue lives. Particularly vulnerable areas include the fuselage station 325 bulkhead, the lower fuselage longeron, dorsal longerons, horizontal stabilisers, upper forward fuselage longerons and wing undersurface skins.

Cockpit

The F-5's relatively roomy cockpit is covered by a single-piece frameless windscreens and a frameless upward-hingeing canopy. This is manually actuated, but is cleverly counterbalanced to make opening and closing simple and effortless, although the pilot must assist the process to avoid misalignment of the canopy with its latches and locks. The aircraft can taxi at speeds of up to 50 knots (57.5 mph; 93 km/h) with the canopy open. The windscreens are hinged at its forward end to provide access to the instrument panel. An improved birdstrike-resistant polycarbonate windscreens and composite frame developed for the T-38 Talon is being adapted for use by the F-5A and F-5E, already being installationally compatible with the F-5B and F-5F. The cockpit environment is controlled by bleed air from the engine compressor, which is filtered, pressure regulated and temperature controlled before being ducted into the cockpit. This bleed air is used for cockpit and hydraulic system pressurisation, heating, canopy demisting and for g-suit and canopy seal inflation. Cockpit pressure is equal to outside ambient pressure below 8,000 ft (2440 m), while an 8,000 ft equivalent pressure is held up to an altitude of 23,000 ft (7010 m). Above this, cabin altitude is maintained at 5 psi (34.5 kPa) above outside pressure. Cabin air is used for cooling the avionics bay, supplemented by ram air. The 2.64-US gal (10-litre) liquid oxygen system is sufficient for between 18 and 20 flying hours, and is supplemented by an emergency bailout bottle attached to the parachute pack. The oxygen system mixes cabin air and oxygen in an increasing ratio until, at 30,000 ft (9145 m), pure oxygen only is being delivered. The pilot sits on a Norair-designed rocket-powered ejection seat actuated by one of two triggers in the forward part of the seat armrests. This is basically the same seat as was fitted to the N-156F and today many F-5 operators are considering retrofitting a more modern zero-zero ejection seat. The Northrop SUP allows the ejection seat rail to be modified to accommodate the Martin Baker US10LF. The F-5E's displays are entirely conventional, with rows of analog dial-type instruments and banks of switches, with a circular CRT-type radar screen centrally mounted below the gunsight. Most upgrade packages add modern Multi-Function Display screens and full HOTAS operation of essential systems. This can give a panel with MFDs flanking the HUD and its upfront controller, and with a conventional panel below. This is ideal for conversion training from a trainer or frontline aircraft with conventional instrumentation to a modern fighter. In unmodernised aircraft, the F-5E pilot views the world ahead of him through a small and relatively old-fashioned lead-computing gyro gunsight, but upgraded aircraft have modern Head Up Displays, with all necessary symbology to allow head-up operation.

Cannon

The F-5 is armed with a pair of Pontiac (Colt-Browning) M39A2 20-mm cannon with up to 280 rounds per gun. Some 246 rounds are stored in ammunition boxes below the barrels, with the rest in the feed mechanism. These fire up to 1,500 rounds per minute. The F-5F's single cannon uses a single smaller ammunition box, limiting ammunition load to 140 rounds, including those in the feed mechanism. Brazil is keen to retain the twin cannon of the F-5E after any upgrade, and this has proved the major stumbling block to Northrop selling its Tiger IV upgrade to the Força Aérea Brasileira, since installation of APG-66 necessitates removal of one cannon.

Weapons

The Brazilian F-5Es are used primarily in the air-to-ground role and as such carry a range of air-to-ground weapons, many of them indigenously produced by the local Avibrás company. These include the 250-lb (113-kg) AV-BAFG-120, and the 500-lb (227-kg) AV-BAFG-250, based on the US Mk 81 and Mk 82 and available with slick or retard tails. The aircraft also use SUU-series napalm cannisters. Unguided rockets available include the spin-stabilised 37-mm SBAT-37 (fired from the seven-round LM37/7 pod), the non-spinning 70-mm SBAT-70 (fired from a variety of pods, housing from two to 19 rounds) and the 127-mm SBAT-127 (based on the American 5-in Zuni) and fired from a two- or four-round launcher. The twin 20-mm cannon are also used for strafing. For self defence, AIM-9 Sidewinders are carried on wingtip launch rails.

Radar

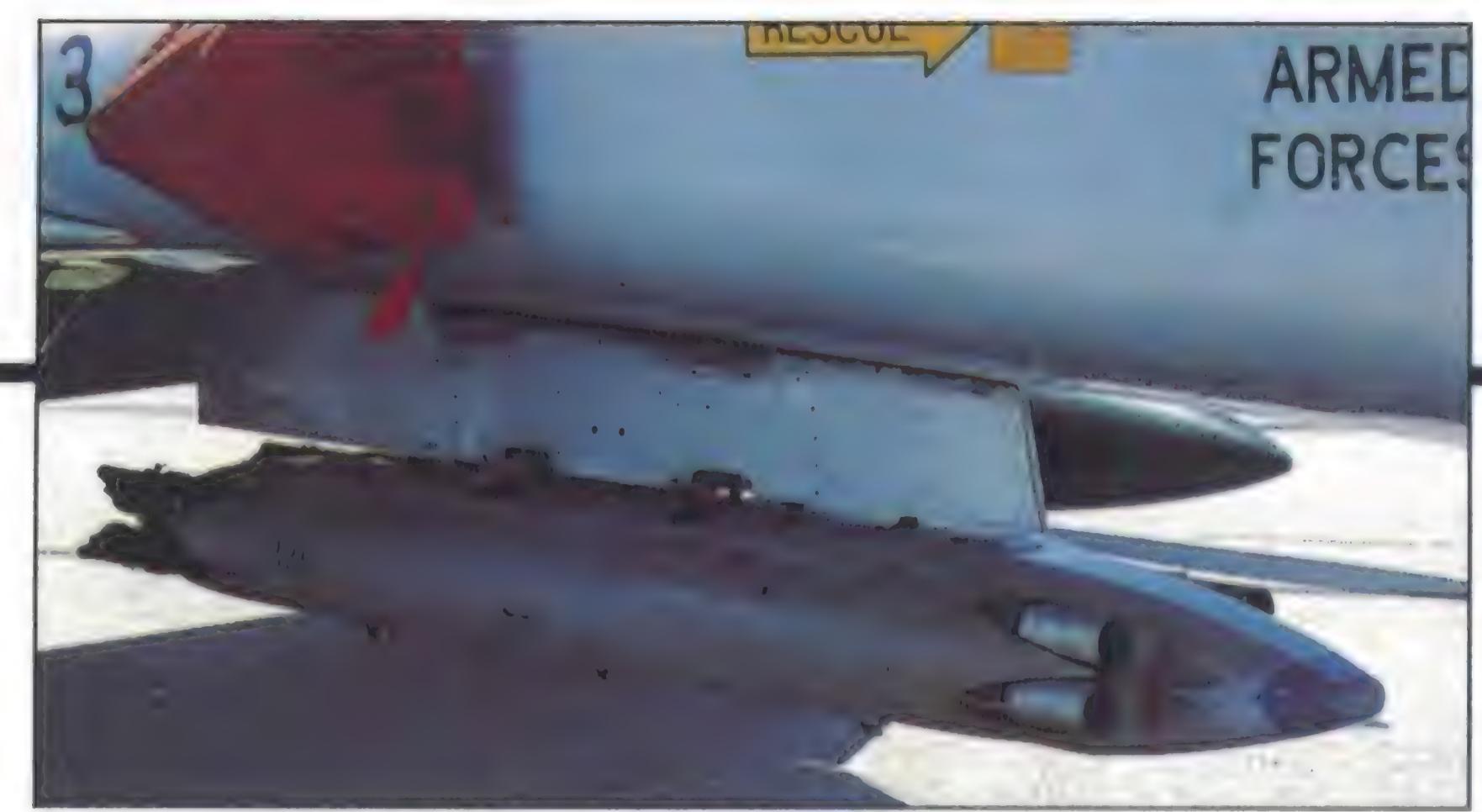
The F-5Es of the Brazilian air force are equipped with the F-5E's original Emerson Electric AN/APQ-159 radar. This lightweight micro-miniature pulse radar has a range of about 20 nm (23 miles; 37 km) and a 5-in (12.7-cm) diameter CRT display. It is augmented by an AN/ASG-31 lead-computing optical sighting system. By modern standards the APQ-159 lacks range performance, target discrimination and resistance to ECM, and a key element in most of the upgrades now being applied to the F-5 is a modern pulse-Doppler radar. Brazil is actively seeking to upgrade its F-5Es, and will almost certainly include a new radar. This may be the indigenous SCP-01 being developed for use in the AMX, or may be the APG-66 which forms the cornerstone of Northrop's Tiger IV upgrade. Other potential radars include the FIAR Grifo (already used in Singaporean F-5Es) or the Elta EL/M-2032 (used in upgraded Chilean F-5Es and F-5Fs). Any of these radars would confer a dramatic improvement in both air-to-air and air-to-ground capabilities.

Colour scheme

Brazilian F-5Es were delivered in a three-tone camouflage using similar shades to those applied to USAF F-5s used in Vietnam and, indeed, to VNAF F-5Es. The batch of second-hand ex-USAF aircraft was delivered in their USAF colour schemes, so most were grey overall (being ex-425th TFTS aircraft) while a handful wore Aggressor-style colour schemes. National insignia consisted of a yellow and green fin flash, vertically divided, carried high on the tail, and green and yellow stars above and below each wing. Aircraft from the 1°/14° GAv wear a blue band across the fin top, with four white stars flanking a smaller yellow star, they also carry the tailcode 'CO'. Some carry sharksmouthed underfuselage tanks. Aircraft of the 1° GAvCa have started to receive 'SC' tailcodes and wear individual squadron badges. Aircraft with tailcodes tend to have the legend FORCA AEREA BRASILEIRA in small block letters along the fuselage, just above the wing root.

Northrop F-5E Tiger II 1° Escadron 1° Grupo de Aviação Caza Terceira Força Aérea Força Aérea Brasileira Santa Cruz AB

The F-5Es of 1°/1° GAvCa, arguably the Brazilian air force's senior flying unit, proudly wear the fighting ostrich insignia and 'Senta a Pua' (Give 'em Hell/Send 'em to Hell) motto originally used when the unit flew P-47Ds with the USAAF's 350th Fighter Group in Italy during World War II. They also use the same 'Jambock' callsign and use this as the unit nickname. The squadron is one of three operating the Tiger II, the others being the co-located 2°/1° GAvCa and the 1°/14° GAv at Canoas. These three squadrons all report to the Third Air Force at Brasília and share the 51 surviving examples of the 36 F-5Es and four F-5Bs originally delivered from 1975, and of the 22 ex-USAF F-5Es and four F-5Fs delivered in 1989.



Above: The Canadian-developed SUU-5003B/A pod, built by Bristol Aerospace, is based on the US SUU-20 dispenser, and can carry six BDU-33 practice 'blue' bombs or four 70-mm CRV 7 rockets.

Below: This AETE CF-116A is carrying a trials load of two Mk 20 Rockeye CBUs and a centreline camera pod to record the separation tests.



Above: The F-5E's 20-mm M39A2 cannon installation is supplied with 280 rounds per gun.

Below: The Hsiung Feng 2 air-launched ASM entered service with the Republic of China Air Force in 1995. The turbofan-powered missile has a range of 80 km (50 miles) and a 225-kg (500-lb) warhead. Behind it is a Taiwanese-developed CBU and an M117 bomb. In the foreground can be seen the tails of 500-lb Mk 82 Mod 1 Snakeye bombs which are also being carried by the 46th TFS Aggressor F-5F in the line-up.



Northrop F-5A Royal Norwegian Air Force No. 336 Skvadron Rygge AB

This Kongelige Norske Luforsvaret/Royal Norwegian Air Force F-5A is not actually a Tiger-PAWS aircraft but, despite this, it has been carrying the banner for 336 Skv and its NATO Tiger credentials since it made its public debut outside Norway at the 1994 Battle of Britain air show, at RAF Leuchars. This aircraft, 208, is reportedly a high-time F-5 that did not receive the 1991 KNL structural upgrade from Bristol Aerospace and so it will soon be withdrawn from use.



Radar warning receiver

Norwegian F-5Bs were fitted with nose-mounted AN/ALR-46 radar warning receivers between 1984 and 1986. Litton developed the ALR-46 in the early 1970s, as a replacement for APR-25/26 and APR-36/37, and it is available in both digital - (V)3 – and analog - (V)6 – versions. ALR-46 can process up to 16 threat signals at once, in the 2- to 18-Ghz bands, and is tied into the ALE-40 chaff/flare dispensers later fitted to Norwegian F-5s. The ALR-69 Compass Ties RWR was developed from the ALR-46 in 1976, by Dalmo Victor. This version is fitted to the KNL's F-5As. ALR-69 can detect higher-frequency missile guidance radars, not just the tracking radars, and so can warn the pilot of approaching missile vectors.

Powerplants

The prototype N-156F went supersonic on its first flight, despite being fitted with non-afterburning General Electric YJ85-1 engines. Production F-5As were fitted with 4,080-lb (18.1-kN) J85-GE-13 turbojets. Higher-powered (4,300-lb/19.1-kN) J85-GE-15 engines were offered to the USAF for its initial F-5As. The louvre doors on the intakes, situated towards the rear of the fuselage, provide additional air for the engines during take-off and low-speed flight (below 530 km/h/329 mph).

External fuel

One of the obvious recognition features of the early-model F-5A/Bs were their 'coke-bottle' area-rulediptanks. Each of these integral tanks can hold 50 US gal (189 litres). The jettisonable centreline tank can carry 150 US gal (568 litres). Two additional 150-US gal tanks can be carried underwing.

F-5 Tiger-PAWS

At the hands of New York's Sierra Technologies, 15 KNL F-5s (seven F-5As and eight F-5Bs) underwent the Tiger-PAWS upgrade during 1993 and 1994. Tiger-PAWS (Programme for Avionics and Weapons Systems) is intended to allow the F-5 to act as a lead-in fighter trainer for the F-16, and so adds a comprehensive avionics upgrade and new MIL-STD 1553B databus to the elderly Freedom Fighters. Hand-in-hand with this, Bristol Aerospace undertook a structural upgrade of some Norwegian F-5s to allow the Tiger-PAWS aircraft to serve into the next century. Several non-upgraded aircraft remain in service also, though these are being gradually phased out.

Chaff and flare dispensers

Like many F-5 operators worldwide, Norway has adopted the Tracor AN/ALE-40 chaff/flare dispenser system for its aircraft. ALE-40 was originally developed for the F-4 Phantom, but Tracor has since adapted it for a wide variety of aircraft. F-5s can carry the ALE-40(V) 7, 8 and 9 variants and the 45-round dispensers are usually scabbed onto the rear of the aircraft (on both sides), under the fin. ALE-40 can carry 30 RR-170 chaff bundles and 15 MJU-7/B flares.

Arrester hook

Norway's F-5s were specially modified to cope with the extreme climatic conditions they encountered and, as a result, were referred to by Northrop as F-5A/B(G)s. An arrester hook was an essential piece of equipment for operations on icy runways.

336 Skvadron

Rygge-based 336 Skv is the last of six F-5 squadrons in the KNL. It now plays a vital role in training, and 'Europeanising' Norwegian F-16 pilots who have undergone their initial jet training in the United States. The squadron badge comprises swallow on a red lightning bolt, but 336 Skv has now adopted a Tiger squadron identity as evidenced by this brightly-painted aircraft.

Northrop F-5 Weapons



Above: The first and third prototype F-5As (N-165F until 1962) are seen here both carrying a single Mk 84 2,000-lb bomb on the centreline, and a pair of 750-lb M117 bombs underwing.

Left: Arrayed under the N-156F prototype, early in its career, is this sizeable (and unlikely) range of weapons. From front to back, they are arranged roughly in rows which include: GAR-8 (later AIM-9B) Sidewinders and AIM-101 (later AIM-7C) Sparrows; GAR-1D and -2A (later AIM-4A and -4D) SARH and IR-homing Falcon AAMs, 5-in rockets and a B28RE nuclear weapon; a dummy, cutaway gun pod, Mk 84 2,000-lb bomb, M117 750-lb bomb, practice bomb dispenser and a 19-round LAU-61 rocket pod with 19 2.75-in rockets. The hidden store labelled 'secret' resembles, in size and shape, the 2,000-lb B43-1 nuclear weapon.

Below: The AGM-12 Bullpup, as seen on this USAF F-5B, was a first-generation, command-guided ASM that proved very effective in Vietnam. It was replaced by the AGM-65 Maverick.



Above: In 1979 Northrop began trials with the General Electric GPU-5 30-mm cannon pod. A loaded pod weighs less than a full, standard 275-US gal(1041-litre) fuel tank.

Right: Saudi Arabia prompted (and funded) the F-5E's AGM-65 capability. This is an early trials aircraft carrying an AGM-65A. Note the Mk 82 bomb acting as a counterweight.



Left: From its earliest days in Vietnam, napalm has always been a favourite F-5 weapon – as simple and straight forward as the aircraft itself. These 4441st CCTS F-5As have just dropped three napalm tanks on Arizona's Gila Bend Range.

Below: The prototype F-5A (N-156F) is seen here, firmly wedged to the ground, with three TERs and a highly fanciful 9,000-lb (4082-kg) warload of 18 Mk 82 bombs.





This was Northrop's lightweight family in about 1974, headed by the superb, mould-breaking YF-17 and with a camouflaged F-5E, an F-5A, an F-5B and a T-38. Northrop had hoped that the YF-17 would take over from the F-5E as the main FMS/MAP fighter, but that distinction was eventually to fall to the rival General Dynamics F-16. From this angle the recontoured spine and LERXes of the F-5E are clearly visible, as are the aircraft's slightly larger overall dimensions.

by the same amount as would a further 20 per cent increase in thrust. Overall, with its higher thrust and higher lift, the F-5A-21 enjoyed a 23 per cent improvement in sea level rate of climb, a 17 per cent improvement in sustained turn rate (from 8.9° per second for the F-5A to 10.3° per second), a 39 per cent improvement in turn radius, and a 7 per cent improvement in instantaneous turn rate (from 15.5° per second for the F-5A to 17.5° per second).

The addition of the J85-GE-21 engines could have increased maximum speed to between Mach 1.8 and Mach 1.9 if Northrop had concentrated on reducing weight. With the other F-5E improvements, including the increased wing area and new equipment, maximum speed crept up from Mach 1.4 to Mach 1.6 (Mach 1.5 with wingtip AIM-9s fitted). More significantly, maximum cruise went up from Mach 1.2 to Mach 1.45. The new engines allowed even a heavily-laden aircraft to attain more economic cruising altitudes, thereby increasing radius of action and endurance.

From F-5A-21 to F-5E

The USAF selected the Northrop aircraft to meet its International Fighter Aircraft requirement (as the Advanced International Fighter requirement had been renamed), and its decision was announced on 20 November 1970. An initial fixed-price plus incentive contract was signed on 8 December 1970, for 325 aircraft. The single-seat F-5A-21 was formally designated F-5E on 28 December. The contract set a limit of 20 per cent on cost escalation, and laid down that any extra costs should be shared on a 70/30 basis between the government and Northrop.

Such was the urgency accorded to the F-5E that in November 1971 it was decided to allocate six test aircraft, instead of the five planned. The first F-5E was rolled out at Hawthorne on 23 June 1972, and was shipped to Edwards AFB for testing. The prototype made its maiden flight on 11 August 1972, four months before the target date (which had been set in November 1970). Hank Chouteau was the pilot. The first four F-5Es were assembled at Hawthorne (usually a site for sub-assembly only), but subsequent aircraft took shape on the main final assembly line at Palmdale. The first five aircraft incorporated extensive extra wiring for test equipment and recorders, but were still able to fulfil an operational role when the tests ended.

Development did not proceed without a hitch. In order to reduce weight, Northrop redesigned the aft fuselage and was forced to use expensive titanium in the new engine/exhaust shroud. This increased costs and imposed delays. Northrop's costs were also increased by the cancellation of Boeing's SST, the company having taken account of SST sub-contracts in computing its production base for the F-5E. Aggressive marketing of the new aircraft led to higher than expected orders, which helped reduce the losses, much to the surprise of the USAF.

Unfortunately, the J85-GE-21 engine proved less reliable than had been hoped, and malfunctions were experienced during August, leading to a suspension of flight trials between 21 September and 16 December. Even though flight testing was then resumed, the engine was not formally re-approved until 25 April 1973.

Of the 13 F-5Es accepted by the air force during FY73, six were used for testing and seven went to equip TAC's training unit, which was intended to work up to an initial establishment of 20 F-5Es, in addition to its twin-stick F-5Bs. The first F-5E entered service with the 425th TFTS on 4 April 1973, before flight testing was complete. The Air Force gambled that subsequent testing would not throw up further problems, and hoped that the initial batch of aircraft would not need major modifications. The 425th TFTS fulfilled the same role as the 4441st CCTS had done, of providing crew training for F-5 customer nations.

Inflation, development delays and more advanced equipment made the F-5E a considerably more expensive aircraft than the F-5A had been. The first F-5Es had a flyaway cost of \$2.1 million with \$1,625,000 for the airframe, \$426,000 for the installed engines, \$47,000 for electronics, \$5,000 for ordnance and \$17,000 for armament. The addition of radar brought with it a heavier maintenance load, and the new variant was found to need 20 MMH/FH, while the F-5A by then averaged 16 MMH/FH. Within a year of entering service, however, the USAF's 425th TFTS was recording less than 12 MMH/FH, although few could have predicted this.

F-5E equipment fit

MAP and FMS F-5Es were sold with a delivery package which included five non-jettisonable external pylons, two wingtip missile launch rails, one centreline 265-US gal (1003-litre) tank and a baggage pod. Other fuel tanks (including the wingtip tanks) were optional items, as were the RF-5A-type reconnaissance nose and the inflight-refuelling probe. Weapons and jettisonable pylons were classed as war readiness material and had to be separately ordered under agreements with the US government rather than through Northrop. The standard avionics fit included Hoffman Electronics AN/ARN-56 TACAN, Magnavox AN/ARC-50 UHF, AN/APX-72 IFF/SIF, automatic UHF DF, AN/AIC-18 intercom, SST-181 X-band Skyspot radar transponder and a new solid-state attitude and heading reference system.

Although the F-5E had been developed with an emphasis on air-to-air capability, the secondary ground attack role was not ignored. Indeed, two of the earliest FMS customers for the F-5E – Iran and Saudi Arabia – both acquired the aircraft primarily to fulfil an air-to-ground role. Northrop attempted to clear the F-5E to use new weapons to complement the aircraft's increased sophistication. The third F-5E tested the LATAR (laser-augmented target acquisition

and recognition) system, a laser designator, spot tracker and EO sensor packaged into a streamlined fairing. The aircraft also tested AGM-65 Maverick ASMs, which were adapted to the F-5 initially to meet a Saudi requirement. Another weapon tested on the Tiger II was MBB's submunitions dispenser designed for the Tornado.

Whereas Northrop-built F-5As delivered to different customers differed very little, F-5Es were delivered with a bewildering assortment of optional items. The Litton LN-33 INS was specified as an option by Iran, Saudi Arabia and Brazil among early customers, and later became virtually standard. Saudi Arabia also specified an Itek/Dalmo Victor ALR-46 RHAWs. Saudi Arabia and Taiwan both requested a coherent pulse-Doppler radar, but this was not then available. Brazil and Chile specified Collins VHF-20 radios and VOR/DME, while Iran, Malaysia and Taiwan received AN/ARN-84(V) TACAN. Other options offered included a semi-conformal Tracor AN/ALE-29 chaff/flare dispenser, Collins DF-206 low-frequency ADF, and Collins ILS and flight director. Northrop even cleared a semi-conformal installation of the AN/ALQ-171(V) jammer for use on the F-5E. This was belly-mounted but did not interfere with the centreline pylon. Some optional F-5E improvements were more apparent externally. To improve directional stability, Northrop offered a dorsal fin fillet, which was an extension to the base of the fin leading edge. This was fitted to aircraft built for Brazil, Chile, Kenya, Mexico, Morocco, Sudan and Tunisia.

A flattened nose radome was developed during early wind-tunnel testing of RF-5E nose shapes, since it was discovered that a flat oval cross-section at the nose was found to eliminate directional stability problems, especially at high angles of attack. This new radome was fitted to aircraft delivered to Bahrain, some Korean F-5Es and F-5Fs, some Malaysian F-5Es, all F-5Es and F-5Fs delivered to Mexico, the last Singaporean F-5Es, later Swiss aircraft, a handful of Taiwanese F-5Es and F-5Fs, and to later Thai aircraft. The same radome was retrospectively added to US Navy F-5Es, which were radarless anyway.

F-5F – the Twin Tiger

Production tooling for the F-5E was 75 per cent common with F-5A tooling, while the aircraft parts inventory was 40 per cent the same. The F-5E could even use 75 per cent of the F-5A's ground support equipment. Despite its higher performance and different avionics fit, Northrop had not initially anticipated any requirement for a two-seat version of the Tiger II. Initial operational experience soon showed that a two-seater based on the F-5E would be a worthwhile development, since the performance differential between the F-5B and the F-5E was a wide one, and there were appreciable operating differences.

Production of the F-5A had terminated in March 1972, and the last RF-5A had rolled off the line in June 1972, but the F-5B remained in production to cover the trainer requirements of the first F-5E customers, since the two-seat Tiger had still not been approved for production. On 15



May 1973, the Air Force gained Congressional approval to allocate \$3.1 million (\$1.9 million from FY73, the rest from FY74) to examine Northrop's proposal to develop a two-seat version of the Tiger II.

Instead of simply building a trainer aircraft with the nose of the F-5B (perhaps with radar) married to the wing, fuselage and engine of the F-5E, Northrop chose to produce an entirely new two-seat forward fuselage. This was stretched by 42 in (107 cm) to accommodate the second cockpit, instead of locating the front cockpit further forward in the nose avionics and cannon bays, as had been done in the T-38 and F-5B. This allowed the F-5F to retain one of the F-5E's 20-mm cannon (the port cannon), with a half-sized 140-round ammunition tank. Because a barrel-like ram air intake projected from the starboard cannon port, some have suggested that two cannon were fitted. This is entirely untrue. The rear seat was raised 10 in (25 cm) above the front seat (as in the T-38 and F-5B) to give the instructor an adequate forward view. The rear cockpit contained a radar display, in addition to the full dual controls. It did not include a lead-computing sight, which was confined to the front cockpit only.

The F-5F flew for the first time on 25 September 1974. The pilot was Dick Thomas, the location Edwards AFB.

Rollout of the first F-5E was highly stylised and showbiz. The prototype was decorated with a blue cheatline running from the cockpit back along the spine and across the tailfin. The aircraft also had a tiger's head on the fin and the designation F-5E on the side of the nose.

The first F-5F prototype flies near Edwards AFB. The F-5F differed from the T-38 and F-5B in having a considerably extended nose, and this allowed retention of one cannon. Development of the aircraft was not launched until after the first F-5Es had been delivered, and early Tiger II training requirements were met by the F-5B. The first F-5F flew on 25 September 1974.





A pair of Royal Jordanian Air Force F-5E Tiger IIs patrols over the desert. Jordan's air defence still relies heavily on the F-5E, using the aircraft to augment the two squadrons of Mirage F1s, although the Tiger's primary role in Jordan is ground attack. Jordan's F-5Es have already undergone a modest avionics upgrade and have been made compatible with the Hughes AGM-65D Maverick. The aircraft have served with Nos 1, 6, 9, 11 and 19 Squadrons, but the force has been reduced in recent years. Seven F-5Es were even sold to Singapore to help fund the upgrade of the remaining aircraft.

Far right: An F-5F of the Imperial Iranian Air Force demonstrates its scintillating performance and impeccable handling characteristics. Iran was among the first nations to sign for the F-5E, just as it had been with the F-5A. They were regarded as little more than a stop-gap by the Iranians, who hoped to replace them with F-16s. Indeed, when the revolution swept away the Shah and his pro-Western regime, 160 F-16s were already on order. Instead of retiring its F-5Es and F-5Fs, the new Iranian regime actually kept the aircraft in service with Vietnamese and Israeli assistance, and with material supplied under the secret 'Irangate' deals. The Iranians had a long history of F-5 operations, and had established a high level of infrastructure and expertise. A small number of F-5s remain in service in Iran even today.

Unusually, the second F-5F made its first flight on the same day as the first. These two aircraft joined the F-5E/F-5F Joint Test Force at Edwards, where development proved swift and trouble free. Even during the test period, the aircraft were used as sales demonstrators and for media orientation flights; *Aviation Week* sampled the F-5F in time to publish an account in its 26 May edition. The F-5F was slightly heavier than the F-5E and had slightly inferior take-off performance. It was, however, still a very hot ship by comparison with the original F-5A or F-5B.

TigerEye

Northrop originally intended to provide a limited reconnaissance capability for the F-5E by installing an RF-5A-type nose containing four KS-121A cameras in six different configurations. Such a nose was fitted to a handful of Saudi F-5Es, which were used in the tactical reconnaissance role pending the availability of the dedicated RF-5E TigerEye. The modification reportedly took 100 man-hours per aircraft in the factory, and while theoretically reversible 'in the field' a change would have taken even longer outside the factory. By the mid-1970s this original nose offered inadequate volume for a modern reconnaissance suite. The F-5E was too small to carry a high-drag recce pod, and had only limited ground clearance with its short-stroke undercarriage. The answer was to redesign the nose to provide integral bays which would provide increased volume. Northrop went back to the drawing board and designed an entirely new nose section (8 in/20 cm longer than that of the basic fighter) with 26 cu ft (0.74 m³) of capacity, nine times the space available in the RF-5A.

The dedicated RF-5E TigerEye offered virtually the same level of capability as the RF-4E but in a smaller, cheaper airframe which was compatible with existing F-5E fighter fleets. Northrop claimed to be providing 90 per cent of the capability of the RF-4E at about 60 per cent of the life cycle cost. The aircraft was optimised to appeal to existing F-5E operators who could not justify procuring a separate dedicated type for the reconnaissance mission.

In marketing the RF-5E, Northrop was keen to stress the civil applications of the aircraft, which it listed as aerial photography in support of conservation and administration of natural resources, monitoring of changing water levels in lakes and rivers, prospecting for oil, analysing crop disease, locating routes for highways, mapping boundaries, identifying pollution sources and assessing damage to timberland by fire, insects or disease. The aircraft's rapid reaction and flexibility allowed rapid, repeated observation or surveillance, which, said Northrop, would be particularly useful in disaster situations such as floods, earthquakes or volcanic eruptions.

To make the best possible use of the available space, and to provide maximum flexibility, sensors were installed on pallets weighing up to 350 lb (160 kg), which were loaded into the nose through the V-shaped door in the underside

that incorporated the vertical and vertical/oblique camera windows. The front portion slid forward on rails to provide access to the forward oblique camera, a single KS-87B, which could be carried with any of the pallets.

Pallet 1 was designed for low-to-medium altitude day/night photography, and contained a CAI KA-95 medium/high-altitude panoramic camera, a Fairchild KA-56E low-altitude panoramic camera and a Texas Instruments RS-710 infra-red line scanner. An alternative Pallet 1 combined a KA-95 and the RS-710 with a CAI KS-87B vertical combat mapping frame camera. Pallet 2 was used for low-level oblique photography or high-altitude panoramic photography and combined a CAI KA-93 high-altitude panoramic camera with a KA-56E. Pallet 3 was for high-altitude vertical or LOROP missions and contained a single Zeiss KA-108M LOROP frame camera. This could provide coverage at oblique ranges of up to 30 miles (48 km) from the aircraft's ground track. CAI-190 and 196 cameras could also be fitted in the LOROP pallet, or the Actron 698 or 700 systems. Pallet 4 was a dedicated night pallet, and contained a Texas Instruments RS-702 IRLS plus a K-98 covert laser line scanner enhanced for night imaging. A terrain-following radar was offered as an alternative to the nose-mounted forward oblique camera. A 'growth pallet' contained a Zeiss RMK-21/23 aerial survey and photo-mapping camera, with a KA-56E and a KA-95.

Video system

The new variant incorporated a TV viewfinder with a CRT display. A video camera was mounted in the lower fuselage, just ahead of the pilot's feet, mounted at a 50° depression angle and with a 50° field of view from its 3:1 zoom lens. This gave a better view, with greater resolution and field of view than would have been possible using the naked eye. It was used for locating targets, and for maintaining an accurate line over the ground during mapping runs. The system could also be used as a sight for updating the INS. The camera trigger was mounted on the left-hand side of the stick, with camera status lights and mode control selectors up front on the instrument panel beside the HUD. An integrated sensor control system (ISCS) panel on the port console had feet-remaining film indicators, altitude and ground speed selectors and on-off-stereo selectors for each camera station. It also had scan angle selectors for the IRLS. ISCS allowed many operations to be automated, thereby reducing pilot workload.

The US government approved development of the new variant in March 1978. An F-5E (71-1420) was leased back from the US Air Force and converted to serve as the RF-5E prototype. The leasing cost, and the rest of the development costs, were funded entirely by Northrop. This prototype undertook its first flight less than a year later, on 29 January 1979, from Edwards AFB with Darrell Cornell at the controls. The RF-5E prototype – the only RF-5E to



fly in full USAF markings – was converted back to F-5E standards and was eventually sold to Brazil, but only after it had reportedly spent a short period with the 425th TFTS at Williams.

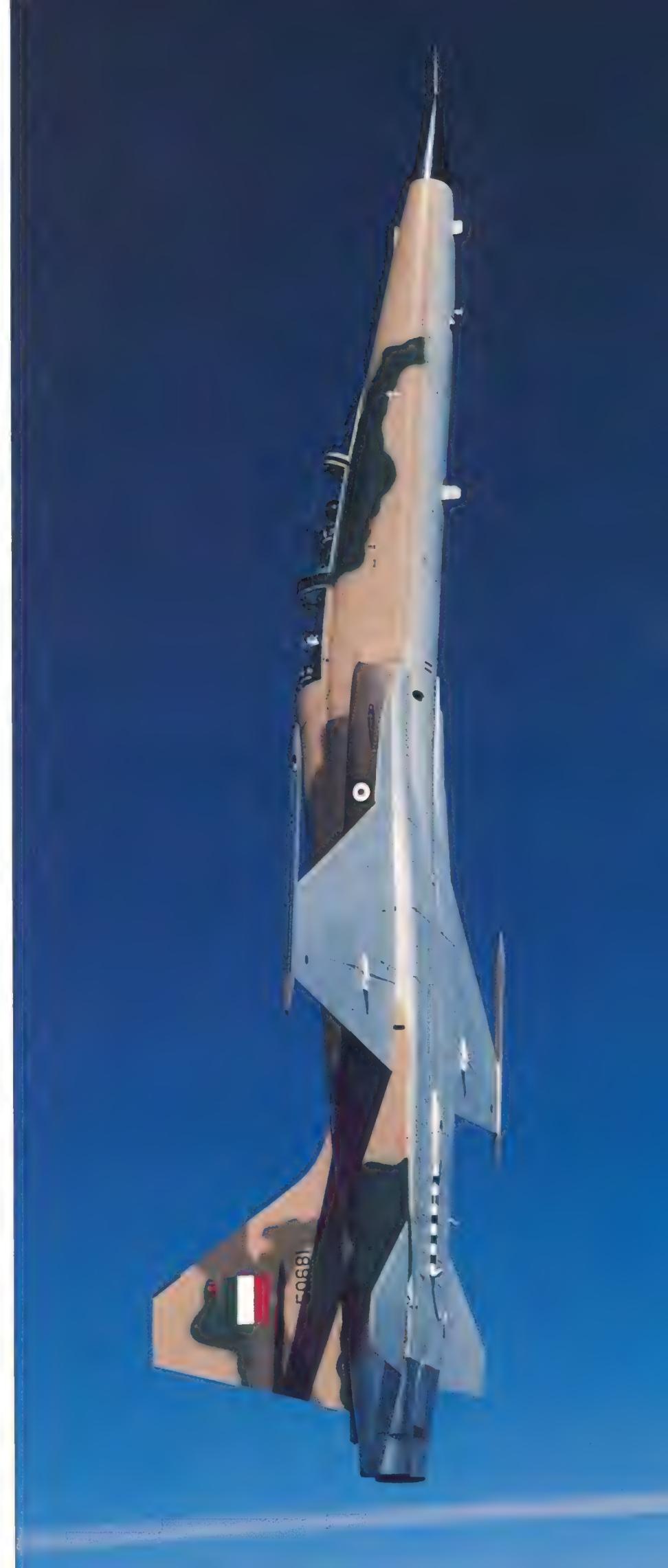
While it was possible to retrofit the TigerEye nose on an F-5E fighter, it required the strengthening of several fuselage keel beams and was not recommended as a cost-effective option, although the prototype was converted to RF-5E configuration in just this way. Northrop anticipated a worldwide market for between 100 and 150 RF-5Es, but was to be disappointed, perhaps because of the aircraft's cost, which was 50 per cent higher than that of a standard F-5E with its camera systems. Prospective customers listed by Northrop who failed to order the type included South Korea, Switzerland and Taiwan. The launch customer was Malaysia, who took two aircraft, while Saudi Arabia took 10 more. Singapore also converted eight of its own F-5E fighters to RF-5E configuration.

Latin Tigers

While it remained implacably hostile to what it saw as European colonialism in the rest of the world, the USA jealously guarded its hegemony in South America, which it saw as being a captive market for US weapons. This was not entirely cynical. The USA provided the continent with massive aid, and preferred this to be spent on social and economic programmes, hoping to prevent a costly arms race between leading Latin nations. Unfortunately, America's unwillingness to see Latin American countries 'wasting' money on advanced combat aircraft (and its subsequent unwillingness to entertain orders for such aircraft) led to these nations turning to Britain and France for military equipment.

America intervened when it could and also resorted to threats to cut aid whenever money was spent on foreign military equipment. These tactics were ineffective, however, and a number of Latin American countries (many of whom had requested F-5s and been turned down) turned instead to the French Mirage. Venezuela became the first Latin American F-5 operator, although it acquired its aircraft from Canada, and these were first-generation Freedom Fighters. Despite the widespread introduction of the Mirage III, there was still a market for the more advanced Tiger II, although US policy prevented Northrop from exploiting it. Finally, in 1973, President Richard Nixon sanctioned a renewal of limited arms sales (still to be approved on a case-by-case basis) to South American countries. In 1974, Northrop was given State Department permission to reopen negotiations with Brazil, which placed an order for 42 aircraft in a \$111 million contract.

Chile had first expressed interest in the F-5A during 1967, but had acquired Hawker Hunters when the Northrop fighters were refused. Allende's Marxist-leaning government was offered MiG-21s to replace the Hunters





These Saudi Tiger IIs, seen during their long delivery flight, have their flaps deployed to maintain station with their KC-130H tanker as it streams two refuelling hoses. The two closest aircraft are RF-5Es, not TigerEyes but standard F-5Es fitted with RF-5A-type camera noses. These aircraft were used by the Saudis pending the development and delivery of the full standard RF-5E TigerEye. This was a unique sub-variant of the F-5E and was used only by Saudi Arabia.

Far right: All fitted with the flattened 'Tigershark'-type nose radome, these F-5Fs of the Republic of China Air Force exhibit a variety of colour schemes. Taiwanese F-5s fulfil air defence, ground attack and even adversary roles. The country is today the largest operator of the F-5, with some 300 aircraft in 15 squadrons. The aircraft are gradually being replaced by F-16s and by the indigenous IDF Ching Kuo, but the aircraft is set to enjoy many more years of productive service, albeit in dwindling numbers.

but left the procurement decision to the air force, which favoured the Northrop F-5E. Incredibly, Marxist Chile's request for the aircraft was approved, although by the time the aircraft were delivered Allende had been overthrown and replaced by a military dictatorship under General Pinochet. Pinochet's poor human rights record led to the imposition of embargoes during the late 1970s and 1980s, and this made support of the F-5Es extremely difficult. At one stage the aircraft had to be towed to and from the runway to save engine life, and they were put up for sale, with interest being shown by Brazil. Improved relations with the USA led to better serviceability, while the growing capability of Chile's own aircraft industry had already mitigated the worst effects of sanctions.

Diplomatic clashes with the USA over illegal immigration from Mexico prevented a 1980 request for F-5Es from coming to fruition, although a new order placed in 1981 was accepted. The final Latin American customer for the F-5E was Honduras, which received 12 refurbished ex-USAF aircraft in 1987 after the US vetoed a delivery of two squadrons of Kfirs (which used the American J79 engine, and which therefore required US approval). These aircraft have since been refurbished and passed on to Chile.

F-5s that never were

While the aircraft was still the N-156F, Northrop hoped to export it to Japan instead of the Grumman F11F-1F for which the Japanese had tentatively signed up. Northrop was confident that its twin-engined configuration offered a major advantage because it was felt that the JASDF had a particular need to do anything possible to prevent civilian casualties. In the event, the JASDF went for a single-engined aircraft in the shape of the F-104. Lebanon was one of the earliest nations claimed by Northrop as a likely F-5A customer, while India, New Zealand, Italy, West Germany and virtually every eventual F-104 customer were at one time or another claimed as likely prospects. West Germany was felt to be a particularly likely customer, and Northrop anticipated the aircraft being used from primitive *autobahn*-type strips, like the Me 262s at the end of the war.

During the early 1980s there were reports that Portugal would receive ex-Dutch NF-5As, perhaps as an interim step pending delivery of the F-20 Tigershark. But there were unbuilt variants as well as non-existent customers.

From the beginning, Northrop viewed the N-156F as the potential basis of a family of aircraft. Even before the prototype had made its maiden flight, Northrop had schemed a navalised N-156D with a larger, folding wing, strengthened undercarriage, higher payload and fuel capacity, and a carrier arrester hook. The same design was dusted off years later, in 1965, and offered to the Royal Australian Navy as the N-285. The N-156E foreshadowed the F-5E, and was powered by a pair of 6,800-lb st (30.25-kN) GE CF-700 turbofans.

Northrop had hoped that a 5,250-lb st (23.35-kN) J85-GE-J1A-powered version of the F-5A (the so-called STOL F-5) with an increased area wing, manoeuvre flaps and other improvements would appeal to the Danish and Belgian air forces (and to the Dutch, who eventually received Canadian-built aircraft with 4,300-lb st/19.13-kN J85-GE-15 engines). This derivative was specifically pitched against the Anglo-French Jaguar and was claimed to match the Jaguar's 'Sod Field' performance. Touchdown speed was reduced from 130 to 99 kt (149 to 114 mph; 240 to 183 km/h) and landing distance from 2,050 to 1,500 ft (625 to 457 m). Take-off distance reduced from 2,410 ft (735 m) to only 1,190 ft (363 m), while take-off weight climbed from 13,000 to 16,892 lb (5897 to 7662 kg), most of the extra weight representing increased fuel capacity. Danish interest never really materialised, but the Belgians were originally to have made a purchase in association with the Dutch, with aircraft for both nations (and perhaps Austria) being assembled by Fokker, which acquired SABCA in anticipation of the deal. Unfortunately, Belgium was unable to reach a decision and agreements lapsed. Northrop was fully stretched building F-5s for Vietnam and others, and was unable to match Fokker's anticipated price. This was contingent on the Belgian order, and eventually the Netherlands went to Canada to obtain a better price and some local industrial participation.

Before designing the F-5E, Northrop had also schemed a version of the F-5A with enhanced air-to-air capability. This was initially offered to Spain. Northrop approached Autonetics (a division of NAA Rockwell), Bendix, Emerson, General Electric, Magnavox, Texas Instruments and Westinghouse for radar bids, specifying an air-to-air radar with a range of at least 20 miles (32 km) and compatible with the Sidewinder. In fact, customers had to wait until the F-5E for an F-5 with radar and, apart from the aircraft manufactured under licence in Canada, no Freedom Fighters even had a lead-computing gunsight.

Another Freedom Fighter customer which originally wanted a radar-equipped version of the aircraft was Norway. The Norwegians wanted an aircraft with terrain avoidance and air-to-air/air-to-ground radar and it was expected that a selection would be made from the Texas Instruments TF radar from the F-111, the Hoffman APG-57, the Magnavox APS-67, the North American Autonetics R-62A and the Emerson radar later used by the F-5E. In the event, development of a radar-equipped F-5A was not funded.

There were also a number of unbuilt derivatives of the later F-5E Tiger II. Switzerland had originally specified a host of improvements for its F-5Es, including greater flap deflection to give steeper approach angles, a more sophisticated ILS and strengthened points to allow the aircraft to be slung from the roofs of underground hangars. The high cost of the aircraft actually limited changes to larger wheels with more powerful brakes and a gaseous oxygen system instead of the usual liquid oxygen system.

Friendly enemies

The very qualities that made the F-5E an ideal alternative and counter to the MiG-21 also made it an ideal MiG-21 simulator for Dissimilar Air Combat Training (DACT). The FY 1975 budget cut 71 F-5Es from the 125 ordered for delivery to Vietnam during 1974. The disappearance of South Vietnam made their non-delivery in 1974 permanent, and they became the core of the USAF's aggressor squadrons.

During the 1960s there was a steady move away from dissimilar air combat training. This was partly due to the increasing emphasis on heavier, missile-armed fighters and the BVR combat for which they were optimised, and partly because of the alarming accident rate suffered in the informal DACT arranged between squadrons or in totally unbriefed 'bounces' by fighters. Instead of ensuring that DACT was properly briefed, with clear rules, and conducted at an appropriate height, it was simply banned altogether. Having a low peacetime accident rate mattered more than having fighter pilots who didn't know how to fight.

The US Navy had never completely abandoned ACM training. The F-8 Crusader was, in essence, a gunfighter, and ACM was its *raison d'être*, but even in the F-4 community forward-looking squadron commanders practised close-in air combat tactics. By 1968, Crusaders had downed 18 MiGs in 25 engagements, while Navy F-4s had downed only 12 in 39 engagements. The difference between the two aircraft lay in training and emphasis on close-in weapons. When the skipper of the USS *Coral Sea*, Captain Frank Ault, returned to the USA he was briefed to carry out a bottom-up review of the tactics and training of Navy fighter aircrew in Vietnam. One of his key recommendations was to increase the focus on ACM training in the F-4 community, and this led directly to the establishment of the new Navy Fighter Weapons School's ACM training syllabus, and to the subsequent formation of dedicated adversary squadrons for DACT. Initially equipped with A-4s, T-38s were taken on charge in 1972 and F-5Es arrived in 1975. F-5Es have remained part of the USN's adversary community ever since.

The disparity between Navy and Air Force combat results became alarming in the summer of 1972. In June the USAF lost as many F-4s to MiGs as it claimed enemy aircraft and, since these claims were probably inflated, this almost



certainly represented a negative exchange ratio. North Vietnamese pilots reportedly avoided combat with grey-painted Phantoms, while actively seeking camouflaged F-4s. USAF Phantoms had become 'easy targets' for Vietnamese aces aiming to build up their scores. The USAF's Fighter Weapons School responded by suspending instructor training and instituting an ACM course for Vietnam-bound aircrew, but this was only a temporary palliative, and the Air Force went about instituting a dedicated DACT programme.

Using T-38s as interim equipment, the new aggressor squadrons were soon re-equipped with F-5Es. These units took DACT on the road, visiting USAF fighter units at

Above: Taiwan's state aeronautical manufacturing organisation, the Aero Industry Development Centre (AIDC), built the F-5E and F-5F as the Chung Cheng. Local content increased following the USA's 1979 abrogation of its 1954 Mutual Defense Treaty. Some 242 F-5Es and 66 F-5Fs were eventually delivered.



Northrop F-5

Located as it is just off the coast of a superpower bent on its destruction, Taiwan takes its defence extremely seriously. Airfields are generously provided with hardened aircraft shelters and there is a national obsession with security. This F-5F is painted in the air superiority grey colour scheme applied to most Taiwanese Tigers and wears a unit badge on its tailfin. Like all Taiwanese military aircraft the F-5 carries a four-digit construction number, consisting of a type-designator and a consecutive sequential identity. Different type designators may be applied to different batches of the same aircraft type. Thus 5401 is the first type 54, but not the first F-5F. The aircraft also carries a sequential serial number, often with a Fiscal Year prefix (not carried on this aircraft).



their own bases to provide structured ACM training courses, and also acted as enemy forces in exercises like Red Flag. The aggressor squadrons re-equipped with F-16s in 1989, but were disbanded in 1990. They had made enemies by their allegedly *prima donna* attitudes, by being more concerned with winning than training and through their anti-Eagle (rather than representative threat) tactics.

Flying the Tiger

When it entered service in the early 1960s, the F-5 was regarded as having remarkably docile handling characteristics and superb agility, while its mere Mach 1.4 top speed made it something of a slow mover. An initial Air Force Flight Test Center report described the aircraft thus: "The performance of the F-5A is impressive. The aircraft has ample thrust subsonically, and can maintain over 3g at 20,000 ft in military power for over 360° of turn at a constant IAS. The aircraft has climb performance comparable with 'Century Series' aircraft such as the F-106A...manoeuvring and handling qualities of the aircraft are excellent."

Today, perspectives are rather different. A Mach 1.4 top speed represents nothing to be ashamed of, but the rather ponderous roll and pitch performance is disappointing, and you would not want to get involved in a turning fight with an F-16. Nor is the 155-kt (178-mph; 286-km/h) approach speed anything to get too excited about. The aircraft's unwillingness to violently depart or spin is still noteworthy, and the aircraft is still an excellent dogfighter when compared with many in-service fighters, albeit not against the later teen-series superfighters.

The F-5 is notoriously unwilling to spin, although it is not impossible. By 1975 two F-5Es had actually been lost in spinning-related incidents when excessive yaw had been applied and when pitch angle had exceeded 40° during manoeuvring. In one case, the C of G had also been well outside limits, due to the unauthorised removal of equipment from the nose without the addition of ballast to compensate. Spinning does, however, require fairly severe mishandling, and recovery is relatively straightforward, although pro-spin aileron is applied to allow adverse yaw to help the recovery, along with full aft (yes, aft!) stick and opposite (anti-spin) rudder.

A Marine adversary F-5 pilot described the F-5E in glowing terms. "The F-5E is a simple aircraft with high

performance. Systems-wise it is simple to learn and honest to fly. One problem when first flying the F-5 is that when you have 15-20 hours in the aircraft you feel like you have 500. It has a lot of favourable flight qualities and is very forgiving. Taxiing is very easy. It has a nice nosewheel steering system and a wide stance. The tendency is to taxi too fast. You have very good directional control after 30-40 kt, using the rudder. It is a delightful aircraft to fly in crosswind situations, very easy to control. You rotate the nose at 150 kt and set a take-off attitude, and at 160 kt you are airborne. You have a very good sensation in the stick, with a bit of forward pressure provided by the bungee feel system. As soon as the airplane lifts off the gear is coming up, at about 180 kt the flaps are coming up and at 200 kt we come out of afterburner and climb in military power. Once you're airborne it accelerates nicely, especially in afterburner. It is a remarkable little fighter, to say the least."

Tigershark – Tiger for tomorrow

Although only three Tigersharks were ever flown, and although the type never reached operational service, the F-5G (later F-20) remains significant even to this day. It demonstrated what could be achieved by developing the basic F-5 to fulfil its true potential, and was tremendously influential in shaping later upgrades. The Tigershark project was officially launched on 4 January 1980, in response to the FX specification for an Intermediate Export Fighter. This was basically a US government call for the private venture development of a tactical fighter for export in circumstances where the supply of a front-line USAF type might be inappropriate. President Carter had made such a development possible in February 1977 by revoking the existing ruling that military aircraft should not be designed specifically for export and by establishing an arms transfer policy which aimed to provide customers with aircraft tailored to the US assessment of their needs and budgets, and not to supply front-line USAF hardware regardless of the situation. The F-5G design drew heavily on an aircraft designed by Northrop to meet a DoD requirement for a Sparrow-carrying, F404-powered F-5 for use by Nationalist China. In the face of improving relations with Communist China, the Carter administration vetoed any sale to Taiwan, and work continued on the F404-powered F-5, although the Sparrow became an option, rather than a baseline weapon.

Far right: The old and the new: pilots from VFA-127 demonstrate a neat formation with two of their F-5Es and one of the squadron's F/A-18s. F-5Es continued in use following the introduction of the F/A-18 while the A-4 was retired. The F-5E's small size and supersonic performance made it an ideal MiG-21 simulator, while the larger Hornet could more accurately replicate modern threat aircraft like the MiG-29 and Su-27. VFA-127 survived longer than most of the US Navy's adversary squadrons, but was due to be replaced by the Reservists of VFC-13 during early 1996.

The F-5 had been designed to meet the threat posed by the MiG-21, but the F-5G was optimised to meet the threat posed by advanced MiG-21 derivatives and by aircraft like the MiG-23. The aircraft was designed to be as economic to operate as the original F-5, but also to be as combat effective as the F-16. This latter factor became especially important from 29 October 1980, following the maiden flight of the General Dynamics F-16/79, a deliberately downgraded F-16 developed specifically for export and powered by an F-4-type J79 turbojet. The F-5G was helped by its performance and economy. It was estimated that the fuel burn of the F-5G would be 60 per cent of that of other Mach 2 fighters, while the aircraft would require less than 50 per cent as many maintenance man hours per flying hour. Subsequent flight tests showed that these estimates were, if anything, over-pessimistic.

The F-20 Tigershark used the proven low-maintenance airframe of the F-5, combined with the powerful yet economical F404 turbofan. The F404 was designed as the successor to the J79, but weighed about half as much, embodying 7,700 fewer moving parts and producing the same thrust with much greater fuel efficiency. The engine produced 70 per cent more thrust than a pair of J85 turbojets. This gave the F-5G an unprecedented level of outright performance and acceleration, including a maximum speed in excess of Mach 2. Climb rate was improved by 57 per cent by comparison to the F-5E, with a sea level rate of climb of 54,000 ft (16460 m) per minute and a ceiling in excess of 53,000 ft (16154 m). Supersonic turn rates were 47 per cent higher than those of the F-5E. Sustained turn rate at Mach 0.8 and 15,000 ft (4572 m) rose to 11.5°/sec. Even at Mach 0.9 at 30,000 ft (9144 m), the F-5G could sustain a turn rate of 6.3°/sec.



Increased weight, and thus increased wing loading, meant that the aircraft did not have such a good turn performance as the F-16, however. From an early stage in the project, many at Northrop expected that a new, enlarged wing would be fitted to overcome this disadvantage. It never was, although from the start the F-5G had redesigned, slightly larger wing leading-edge root extensions that gave a higher maximum coefficient of lift. Although they represented only 9 per cent of wing area the LERXes generated 30 per cent of maximum lift, and by destabilising the aircraft in pitch they improved the instantaneous turn rate by 7 per cent, to some 20°/sec. The new engine was extremely reliable and extremely maintainable, with a modular design reducing maintenance and repair times, and reducing the number of spare engines required.

Internal fuel capacity was unchanged but the F404's lower specific fuel consumption gave the newer aircraft a

The pilots of this F-5 wear black and yellow tiger-striped bonedomes indicating that the unit to which this twin-sticker is assigned is a tiger squadron. The wingtip-mounted missile is a drill round for the AIM-9P Sidewinder. This brown and green camouflage is common on Taiwanese tactical aircraft, but the red construction number, applied like a Chinese air force serial, might indicate assignment to an aggressor unit.





F-5Es of the 64th Aggressor Squadron on the road at a Maple Flag exercise at CFB Cold Lake, wearing a variety of simulated enemy camouflage schemes. A row of 419 Squadron CF-5s is behind the Aggressor F-5s, some of them wearing aggressor-type colour schemes. The USAF's Aggressor squadrons took their unique brand of dissimilar air combat training to USAF fighter units at their own bases and also provided enemy forces during exercises. The USAF's Aggressor squadrons drew their pilots from the elite of the F-15 and F-16 community, and proved to be deadly adversaries.

Marines titles have been seen on adversary F-5Es for some years, at first on some of the aircraft assigned to the US Navy's Fighter Weapons School and then on the aircraft of VMFT-401 at MCAS Yuma. These replaced leased IAI Kfirs with the Marines' sole adversary unit, and no replacement is in sight. The 'Challengers' are largely manned by reservists, reflecting a more widespread move to part-time adversary units that is also reflected in the US Navy.

10 per cent increase in combat radius in the hi-lo-hi interdiction mission, or a 20 per cent increase in CAP endurance. Northrop quoted a 360-nm (413-mile; 665-km) radius with seven Mk 82 bombs, two 275-US gal (1040-litre) tanks and a pair of AIM-9s, or a CAP endurance of 77 minutes, 300 nm (344 miles; 554 km) from base while carrying three tanks and two AIM-9s. In the F/A-18 the engine also demonstrated unparalleled tolerance of throttle mishandling and intake airflow distortion. Thrust response was extremely rapid, even during high-altitude flight or during high-g manoeuvring. The engine required only 1.2 MMH/FH (compared to 3.3 MMH/FH for the J79) and had an MTBF of 190 hours (85 hours for the J79). This made it the ideal engine for the ultra-reliable F-5.

Unprecedented reliability

Northrop demanded tight contractual MTBF and reliability figures from its subcontractors and suppliers, specifying that the APG-67 (for example) should have a demonstrated MTBF of 200 hours (twice the achieved reliability of the APG-66), with guaranteed MTBFs of 4,000 hours for the MFDs, 2,100 hours for the mission computer and 2,000 hours for the laser-gyro INS. Such strictures combined to give the F-5G a 4.2-hour MTBF, and a requirement for 12.8 MMH/FH. This compared well with the F-5E's 3.6-hour MTBF and 14.9 MMH/FH and the F-16's 2.9-hour MTBF and 19.6 MMH/FH. Comparing the F-5G with what it called "the average of contemporary international fighters," Northrop claimed that the aircraft had 63 per cent lower maintenance and operating costs, required 52 per cent less manpower and used 53 per cent less fuel.

Actual commonality with the F-5E included use of a common wing, landing gear and forward fuselage, providing further savings and easing spares and maintenance support for existing F-5 operators. The aircraft's similar handling characteristics also reduced pilot training costs.

There were major changes, too. The intakes were enlarged and moved further out from the fuselage to take account of the thicker boundary layer encountered at higher airspeeds. Northrop expected to go back and enlarge the intake throat area in the production Tigershark to accommodate growth versions of the F404 engine which might have higher mass flow requirements. The fuselage was stretched by 5 in (13 cm) immediately behind the cockpit,

and the internal fuel tanks were rearranged, giving a new avionics compartment in the upper part of the fuselage behind the cockpit. This allowed the avionics black boxes to be repackaged so that all were accessible without removing other LRUs.

The original twin-engined F-5 owed much of its longitudinal stability to its broad flat underfuselage. To retain these contours aft of the wing, step fairings were added on each side of the new narrow circular section rear fuselage accommodating the single engine. Whereas the original F-5 mounted its vertical fin on the frame which ran between the engines, this was obviously impossible on the single-engined Tigershark. Instead, the F-5G mounted its tailfin on banjo frames which encircled the engine.

The Tigershark finally addressed the F-5E's sluggish pitch characteristics. The horizontal tail was enlarged by 30 per cent, and was controlled by a dual channel FBW control system with mechanical reversion and override. The centre of gravity was moved aft and the aircraft was given a closed-loop digital pitch control augmentation system. Improved airflow around the rear fuselage allowed a reduction in fin size, the new fin being mounted on a long fairing, with the brake chute compartment at the rear and a ram air intake at the front.

'Sharknose'

The F-5G also had a broad flat nose radome, rounded in planform but flattened in elevation. This made the aircraft's nose look like that of a shark, and prompted the Tigershark name. A similar flattened radome was offered on some F-5Es and F-5Fs. The new nose contours improved directional stability at angles of attack of up to 40° and reduced the tendency of the aircraft to depart when inverted at low airspeeds.

The skin on the inboard sections of the wing was increased in thickness, to take account of the F-5G's 17 per cent higher empty weight (which was almost entirely accounted for by the fact that the single F404 weighed 1,600 lb/725 kg more than a pair of J85s). Other increases in weight in the F-5G were compensated for by the extensive use of graphite composites to skin the rear fuselage and fin. The higher AUW was counterbalanced by the F-5G's use of heavier-duty wheels and brakes on the undercarriage. These also helped cope with the higher taxiing speeds imposed by the F404's higher idling thrust. The thicker wing skinning permitted the maximum load factor to be increased from 7.33 g to 9 g.

Northrop originally saw a need for two quite different F-5Gs, sharing the same airframe and powerplant combination but with two quite separate avionics fit: one simple and broadly equivalent to that of the F-5E, and the other more sophisticated. The first prototype was completed in the basic configuration (even after it was abandoned as a production standard), with the standard Emerson radar and a simple GE gyro gunsight. This allowed Northrop to work to an extremely abbreviated schedule, with a target first





US Navy adversary F-5Es are not usually fitted with radar, and most have the broad, flat nose radome which improves high-Alpha handling. Following the end of the Cold War many adversary aircraft lost their distinctive red star markings, replacing these with representative threat nation's flags, including those of Iran, Iraq, Libya and Cuba. Warpac-type two-digit nosecodes have been retained, however, usually applied in red and outlined in yellow. This VFA-127 F-5E wears an Iraqi flag on its tailfin, and carries an AIM-9 Sidewinder acquisition round on the starboard wing and an ACMI pod on the port wingtip. Carriage of centreline fuel tanks is unusual on adversary F-5Es, which are usually flown 'clean' in order to maximise performance and agility.

flight date set for September 1982 and with production aircraft available from July 1983. These dates were reflected in the make-believe serial applied to the prototype for its formal roll-out, 77-1983.

The F-5G prototype made its maiden flight on 30 August 1982, in the hands of Russ Scott and pursued by an F-5F piloted by Darrell Cornell. The F-5G reached a planned Mach 1.04 (Scott reporting having had a tough time keeping the speed this low) and achieving all intended test points. Scott was at the controls for the one-hour and nine-minute second flight. He might have liked to stay aloft longer, but was forced to return when the chase F-5F started to run low on fuel. By the time it flew, the F-5G designation was looking increasingly like a liability and the aircraft wore no designation, merely the name *Tigershark*. It did wear its officially allocated serial (82-0062) and the civil registration N4416T.

F-5G – fortune and misfortune

Under Carter's administration, the F-5G designation had been a shrewd one. It inferred that the aircraft was merely a derivative of the F-5E, which no-one need worry about exporting, and which certainly bore little resemblance to the sophisticated teen series superfighters which were to be kept out of the hands of second-rank nations to avoid the evils of proliferation. Furthermore, in a time in which defence spending was unpopular, it was easier to attract funding for development of an existing type than to invite opposition by appearing to be a new defence programme. The fact that anything called an F-5G would be at a competitive disadvantage to anything with F-16 in its designation was felt to be irrelevant, since the full-standard F-16 was simply not available for export to act as a competitor, while the F-16/79's blatantly poor performance (except in the high supersonic regime) rendered it less than a credible threat.

Unfortunately for the *Tigershark*, President Ronald Reagan had replaced Carter on 20 January 1981, and the situation changed almost overnight. Reagan's administration had fewer scruples about exporting advanced weapons. Suddenly, the F-16 was back in contention, and the F-5G designation had unwelcome connotations of obsolescence, compromise and over-simplicity. Adoption of the F-20 designation was a shrewd move, and was a truer representation



These four F-5Es are from the 425th TFTS, for many years the USAF's F-5 training unit, responsible for training air and groundcrew from customer nations. These aircraft wore a variety of colour schemes over the years, from the VNAF camouflage in which some were delivered, through overall silver with broad yellow bands around fuselage, wings and tailfin. The air defence grey colour scheme seen here was the final one, with smart black canopy frames and anti-dazzle panels, and with USAF star-and-bar insignia applied in stencil form only. The unit's aircraft were exported (mainly to Brazil) after the unit disbanded, when the FMS/MAP F-5E training requirement finally disappeared.

of what the *Tigershark* was all about – that it was, effectively, a brand new high-tech fighter more advanced than the F-16 in many key respects.

The first *Tigershark* initially flew with the 16,000-lb st (71.17-kN) F404, but was re-engined with the uprated 17,000 lb st (75.62-kN) F404-GE-100 after its Paris debut. With the new engine, the thrust-to-weight ratio was improved to 1.13:1 and climb performance to 40,000 ft (12192 m) was shaved from 2.2 minutes to 2.1. The second and third F-20 prototypes (82-0063/N3986B and 82-0064/N44671) had both flown by 12 May 1984, and from the start were more representative of the intended production configuration. They were both powered by the F404-GE-100 and featured a lengthened and bulged canopy and many elements of the enhanced avionics fit, including the GE G-200 radar (soon to be redesignated APG-67) and a GE HUD.



Below: A pair of Swiss F-5Es at low level during exercises over neutral Sweden. A handful of Swiss Tigers wear unit markings, but this is rare and means little.

Despite its light weight and small size, the F-20 ceded nothing to the F-16 in terms of its avionics fit. The General Electric APG-67 radar offered the same basic modes as the F-16A's APG-66 and gave virtually identical detection ranges, despite its small antenna. The aircraft was also compatible with a similarly wide range of weapons, which were

cleared on the three prototypes. These included the AGM-84 and GPU-5/A gun pod as well as the AGM-65. The F-20 had a more advanced cockpit than any of its contemporaries, offering some improvement even over the F/A-18 that was then widely regarded as the best fighter cockpit of its time. The aircraft had a wide-angle HUD with an up-front controller and a pair of high-set monochrome CRT MFDs, one being used primarily for radar and the other for stores management plus navigation. Pilot workload was further reduced by the use of input buttons on the control column and throttle for control of sensors, weapons and avionics. In its promotional literature Northrop insisted on referring to this concept of HOSAT (Hands On Stick and Throttle) instead of using the more usual HOTAS acronym. Switch selections were minimised by clever use of automation. Selection of the air-to-air mode on the weapons selector, for example, automatically armed the Sidewinder, generated the appropriate HUD display and DDI display and switched the radar to range-while-search or single target track, as appropriate.

A fighter pilot's cockpit

The cockpit was one of the first to be designed by a close-knit team of engineers, human factors engineers and fighter pilots, and as a result was optimised for low workload. Everything was intuitively right, as demonstrated by the three-position air-to-air weapon selector, which was pushed forward for BVR weapons, clicked back towards the pilot for IR-homing missiles, or pulled fully back for guns. A lucky ANG pilot who flew the aircraft remembered that "everything in the cockpit was designed for the pilot. A recurring thought I had was that if I could design a cockpit, I would have done it just this way."

By 1983 the unit flyaway cost of the F-20 (assuming a minimum buy of 150 aircraft) had reached \$10.7 million. At the same time, the F-16/79 cost \$11 million, and the F-16A \$12.4 million. Projected life cycle costs tipped the scales even more radically in the Tigershark's favour.

Under Reagan the standard F-16 became widely available, and the need for a dedicated FX export fighter evaporated. The USA's allies would no longer accept an aircraft developed exclusively for export, not when the USAF-operated F-16A was available. It became clear to Northrop that it needed to sell the F-20 to the USAF in order to establish the type's credibility, and to provide a large enough customer base to justify launching production. 1984 saw reports that the USAF and ANG were (or were not) interested in or examining acquisition of the F-20 Tigershark. A number of other nations did examine the aircraft, including Jordan (which had a requirement for 36)



and Bahrain (which went as far as ordering an initial batch of four).

By 1985 there were Congressional worries about the high and rising acquisition and operating costs of defence equipment generally, while it was becoming clear that funded F-15s and F-16s would not meet the USAF's planned force structure requirements and could not be delivered within the originally agreed timescale. Northrop saw its opportunity, and on 3 April 1985 made a formal – if unsolicited – bid offering the USAF 396 F-20s at a fixed unit price of FY86 \$15 million. The multi-year contract would cost the USAF \$7,000 million, but would represent a saving of \$5,700 million in F-16C procurement. Furthermore, Northrop offered a fixed-price 20-year follow-on material and spares contract at \$475 per flying hour. Northrop claimed that the F-20 would perfectly complement the F-16: the General Dynamics aircraft offered superior long-range interdiction, while the F-20 offered faster reaction and turnaround times to give a higher sortie rate against closer targets and in the air-to-air role. Northrop's bid came just too late to secure FY86 funding, but resulted in the decision that future fighter procurement should be competitive, in order to drive down costs. The proposal was seriously considered during FY87 budget debates.

Tigershark for the Guard

Although the F-20 represented an excellent alternative to the F-16, the General Dynamics aircraft was firmly established as the standard fighter-bomber equipping the USAF's front-line tactical fighter wings and it was never likely that a second aircraft type would be acquired to fulfil exactly the same role. The only realistic hope for Northrop lay in obtaining an order to meet the USAF Air National Guard requirement for an air defence interceptor to replace the F-106 and F-4.

The best aircraft for the role was clearly the McDonnell Douglas F-15 Eagle, but the aircraft was too expensive, and there were none available for transfer from active-duty units. Furthermore, the F-15's operating and maintenance costs were unacceptably high. Another contender was the F-4 Phantom, in the shape of the Boeing Military Aircraft Company's re-engined and upgraded F-4. The plentiful availability of redundant F-4 airframes meant that this was a cheap option, although the maintenance-intensive and fuel-thirsty F-4 would never be cheap to operate.

The F-20 had already proved its compatibility with the AIM-7 Sparrow, an air force pilot having fired one on 27 February 1985, destroying a target drone with an unusual direct hit. For combat persistence the aircraft could carry four AIM-9s in addition to its two Sparrows, or could even carry six AIM-9s. The aircraft was especially well-suited to the air defence role because its Honeywell Laser INS required no spin-up, aligning in just 22 seconds (concurrently with the 30-second engine start) and conferring on the F-20 the fastest scramble time in the world. Northrop boasted that within three minutes of jumping into his seat, the F-20 pilot could be 10 miles (16 km) from base, 17,000 ft (5181 m) up and flying at Mach 0.9. Most pilots of other air defence fighters would be still waiting for their INS to align, or perhaps be taxiing after an emergency quick alignment which would lead to unnecessary inaccuracy.

The other contender was a new, unflown derivative of the F-16 which promised to have longer range than the F-20, but which also promised to have a higher price tag and a very long lead-time. General Dynamics was having problems building the F-16s that were already on order quickly enough, and had little extra capacity. Furthermore, the F-16 had not been integrated with the AIM-7 Sparrow missile (although test aircraft had carried and fired AIM-7s), nor had it been integrated with the various avionics systems that it would need. The F-20, by comparison, was optimised as an air defence fighter and the thousands of hours flown by the prototypes had gone some way to producing a



mature weapons system. As such, the result of any competition between the two aircraft would be far from being a foregone conclusion, even after two F-20 prototypes were destroyed in fatal crashes.

The phenomenon known as G-LOC (*g*-induced loss of consciousness) was poorly understood during the early 1980s. It had long been known that sustained high-*g* manoeuvring would progressively lead to unconsciousness as blood drained from the brain (going via greying of the vision ('greyout'), tunnel vision and loss of vision ('black-out')), but the term G-LOC referred to a sudden, instantaneous loss of consciousness, without any forewarning and occurring after sustained high *g*. The G-LOC phenomenon was found to be a delayed reaction to a cumulative build-up of *g* applications. It was discovered that older, less physically fit pilots were especially prone to suffer from the phenomenon, but many of those most at risk had no idea of their vulnerability. "How does a slightly senior test pilot keep himself in shape for such exertions?" asked one of the 1983 Paris show dailies. F-20 test and display pilot Darrell Cornell was quoted as replying that "I have been jet qualified for almost 30 years without a break, so pulling *g* is no problem for me. I probably do a little more walking and take a little more exercise now, that's all."

Tigershark nemesis

Just over one year later, on 10 October 1984, Cornell died in one of the F-20s, stalling inverted during a demonstration flight at Suwon AFB, South Korea. G-LOC was blamed. David Barnes was killed in similar circumstances on 14 May 1985 during a display at Goose Bay, Canada, while en route to Le Bourget for the 1985 Paris Air Salon. G-LOC was blamed again. This left only a single Tigershark flying, and the fourth aircraft, being built on production tooling, was destined never to be completed.

This fourth F-20 would have been much closer to the production configuration, and it incorporated many changes. Internal fuel capacity was increased by using an integral tank design instead of a bag-type tank. Capacity rose from 4,400 lb to 5,050 lb, while the aircraft was made compatible with newly designed 330-US gal (1250-litre) external tanks. Changes to the nose allowed an increase in radar antenna size, giving a 30 per cent improvement in look-up detection range (to about 50 nm/57 miles/92 km against a head-on fighter type target). The leading-edge and trailing-edge flaps were redesigned to incorporate three-point drives (instead of being driven at a single point). Actuation speed was increased, and the number of automatic settings was increased. The aircraft was to be powered by a more powerful version of the F404, rated at 18,000 lb st (80.07 kN) instead of 17,000 lb (75.62 kN). The flap and thrust changes were expected to improve turn performance by some 2° per second.

A Swedish J32 Lansen leads a pair of Swiss F-5Es and a pair of Mirage IIISs during joint exercises. In the air defence role the primary weapon of the Swiss F-5E is the AIM-9P Sidewinder, while in the close support role the primary weapons are the AGM-65 Maverick ASM, the indigenous 300-kg bomb and a variety of unguided rocket projectiles.

Far left, top: A Hawker Hunter approaches a motorway strip while three F-5Es await their turn to taxi. The Swiss procured the F-5E as a Hunter replacement in the low-level air defence role, allowing the Hunters to replace ground attack- and reconnaissance-roled de Havilland Venoms. The Swiss make extensive use of temporary airstrips, and these are often associated with underground hangars. Incredibly, the two-seat F-5F cannot use such facilities, because its liquid oxygen system is deemed to be too potentially dangerous in such confined spaces. Switzerland acquired 13 Northrop-built F-5Es and six F-5Fs, and then took delivery of 85 F-5Es assembled by F+W. The Tiger II serves with some seven Flugwaffe squadrons, four of them manned by part-timers and called out only for deployment exercises and training periods. The other three squadrons form part of the Dübendorf-based Überwachungs-geschwader (Surveillance Wing) and are professionally manned.



A quartet of F-5Es of the Republic of Singapore Air Force sports the air arm's new lion's head national insignia and the black kite badge of No. 144 Squadron. The F-5E replaced the Hunter in the air defence role, and has now assumed a tactical fighter role, ceding the primary air defence commitment to the F-16. The aircraft underwent a major modernisation programme from 1990. The retirement of the last Hunter FR.Mk 74s led to the conversion of eight F-5E fighters to RF-5E TigerEye configuration by Singapore Aerospace, and these aircraft equip No. 141 Squadron, co-located beside No. 144 at Paya Lebar. A third F-5E unit, No. 149 Squadron, is based at Tengah.

On 17 November 1986 Northrop announced to shareholders that it saw "no need for further F-20 Tigershark investment," and concluded its contracts with subcontractors and suppliers, bringing the total programme cost to \$1.2 billion (including \$250 million of close-down expenses in 1986). Work on the fourth prototype was abandoned. This decision was prompted by the USAF's decision to buy modified F-16s for the defence of CONUS role, and marked a tacit recognition that the lack of a USAF order had rendered the aircraft virtually unsellable. Northrop was careful to leave the door open, however, and began attempting to sell the entire programme as a package for licence-production. The State Department prevented Northrop from selling the tooling to the likeliest customer – Taiwan – but other nations, including India, were approached. Answering questions after his address to shareholders at their 1989 annual meeting, Chairman of the Board and Chief Executive Officer Thomas V. Jones denied that the F-20 was 'completely dead'. "The F-20 is in what we call 'ready storage'. But we have already taken all the initiatives we intend to take on the F-20. That means that if someone wants to take the initiative, we're ready to build it. The F-20 provided more knowledge to this company and demonstrated our ability almost more than any other product, so you can't ever say it's a loser."

Incidentally, it costs a relatively small amount to keep the F-20 in ready storage." The F-20 project has now died, and the surviving prototype now hangs, in flying configuration, in the Museum of Industry and Technology.

All the effort expended on the F-20 was not without concrete benefit, however. Competition between the F-20 and the F-16 to meet the US Navy's requirement for an adversary aircraft had resulted in a significantly cheaper F-16N, which was delivered to the US Navy at a unit price of only \$11 million (compared to the \$19 million then being paid by the USAF for every F-16C delivered during that period). The possibility of an F-20 buy also drove down the cost of USAF F-16A (ADF)s. Furthermore, the F-20 shaped later upgrades to the basic F-5E.

The final F-5s

In 1976, on the delivery of the 3,000th example of the T-38/F-5 family (one of 70 F-5Es for Saudi Arabia), Welko Gasisch predicted that the aircraft would stay in production until at least 1987. Three thousand aircraft was equivalent to the USAF's total aircraft procurement (all types) over the preceding nine years, and was a major achievement. Production did continue into 1987, as predicted, but only just, and it went no further. The last two F-5Es off the line were delivered to Bahrain on 16 January



1987, stopping off at Wright-Patterson AFB, home of the FMS office which had managed the F-5E export programme. Just over two years later, on 29 June 1989, the very last F-5Es left Northrop's Mojave facility. These were three aircraft assembled from spares and sold to Singapore, and they brought production of the F-5/T-38 family to 3,840. Northrop had produced two N-156Fs, one YF-5A, 635 F-5As, 89 RF-5As, 200 F-5Bs, 792 F-5Es, 140 F-5Fs, and 12 RF-5Es, plus three F-20s but not including the pair of F-5s used in the construction of the two X-29s. Thus the Northrop total was 1,874 F-5s and F-20s (plus 1,190 T-38s and YT-38s). Canadair added 240 CF-5As, CF-5Ds, NF-5As and Bs and CASA added 70 SF-5As and Bs. F&W in Switzerland added 90 F-5Es and F-5Fs, while Korean Air built 68 more, and AIDC in Taiwan built another 308 – bringing the licence-production total to 776.

Upgrades and rebuilds

By the mid-1990s, about 1,500 of the 2,617 F-5s built remained in service, and 750 of the survivors were reckoned to be realistic candidates for upgrades of one sort or another. Modest avionics improvements and other modifications have long been a feature of the F-5. Various operators had their aircraft retrofitted with inflight-refuelling probes, for example, and others (including Jordan and Greece) had



the original seat replaced by a Martin-Baker Mk 10LF zero-zero rocket seat. The first upgrades of the F-5 were of relatively modest scope. Thailand upgraded 20 F-5Es with a GEC HUD/WAC, Litton LN-39 INS, AN/ALR-46 RWR and AN/ALE-40 chaff/flare dispensers during June 1985, adding the HUD and INS to another 18 aircraft. Jordan was also among the first F-5 operators to modernise its aircraft, signing a contract with Smiths Industries in 1985 to upgrade its F-5Es, and the Thai F-5 upgrade began in 1989.

Bristol Aerospace

Although the CF-5 was replaced in its operational role by the CF-188 Hornet, in 1984 it was decided to cancel its planned April 1985 withdrawal and to retain the type as a lead-in trainer, bridging the gap between the CT-114 Tutor and the Hornet. The planned retirement date was immediately pushed back to April 1995. Many felt that the CF-5 would be useful in the lead-in role for much longer (past 2005), although it was plain that even if all 92 surviving aircraft were retained all would quickly exceed their 4,000-hour service life limit and would reach between 5,200 (CF-5A) and 6,100 (CF-5B) hours by the year 2000. A 1985 feasibility study recommended a two-stage (structural and avionics) upgrade to allow the aircraft to serve on into the next century, and to make its cockpit environment more closely resemble that of the Hornet.

Northrop's own SLEP for the F-5 required a regime of frequent, intensive inspections and repairs, but Bristol Aerospace preferred a more permanent solution, replacing critical and difficult-to-inspect components to give a guaranteed increase in service life without too rigorous a schedule of ongoing inspections. It was decided to remanufacture 23 single-seat CF-5As and 33 CF-5B trainers, of the 92 aircraft then remaining in service.

The remanufacturing programme, known as the Depot Level Inspection and Repair (DLIR), was a comprehensive structural refurbishing. Existing aluminium dorsal longerons were replaced by steel components, tunnel brackets were reinforced, and the vertical fin was respinned and reskinned. The horizontal tailplanes were replaced entirely. The undercarriage was replaced, as were the windscreens, the fuel tanks, flexible hydraulic hoses, and the brake chute springs and cables. Aft fuselage formers were replaced with redesigned components, as were the boat tail firewalls, the intake ducts and certain critical bulkheads. Control cables were replaced by nylon-coated cables, while all flight control system bearings were replaced, and all magnesium control system components replaced by more corrosion-resistant aluminium parts. The aircraft were rewired, with provision for a MIL STD 1553B digital databus, and a radar altimeter was installed.

The most vital part of the upgrade was the wing upgrade. Initially, Bristol refurbished 12 wings, replacing cracked ribs and spars and reskinning the entire undersurface. The company also installed quick-disconnect hydraulic and electrical attachments to allow for quick and

This probe-equipped F-5E of Singapore's No. 144 Squadron is finished in a ground attack type dark green and brown camouflage similar to that applied to Singaporean A-4 Skyhawks. Singapore's F-5 upgrade includes the installation of a FIAR Grifo F/X Plus radar and a MIL-STD 1553B digital databus, allowing the integration of a sophisticated new digital avionics suite. This includes a new HUD/WAC, laser INS, cockpit MFDs and HOTAS controls.



Top: The first F-20 displays its original red and white colour scheme, complete with a Paris show number on the nose and a 'Smokewinder' smoke generator on the wingtip. The first F-20 retained the original F-5E type canopy and nose radome, while the later aircraft had a larger blown canopy of entirely new design and also had a larger radome.

Above: The second F-20 prototype first flew on 26 August 1983 and is seen here toting a pair of AIM-7 Sparrows. A large number of distinguished test pilots flew the F-20, including Brigadier General Chuck Yeager, who was retained by Northrop as a consultant. The F-20's compatibility with the AIM-7, coupled with its astonishingly quick scramble time, should have made it front runner in the contest to find a new air defence fighter for the USAF.

Far right: The third F-20 prototype first flew on 6 May 1984 and is seen here toting a pair of AIM-9 Sidewinders and firing podded unguided rockets. This was the only F-20 prototype to survive the test and demonstration programme.

easy replacement of the whole wing. At the same time, it studied the costs and benefits of installing a newly manufactured wing (incorporating quick-disconnect fittings and redesigned structural members), and this became part of the standard DLIR upgrade.

The remanufacturing programme immediately increased service life from 4,000 to 6,000 flying hours, and provisionally as far as 8,000 flying hours. The first 25 aircraft were structurally upgraded and given provision for the planned avionics upgrade, for which they had to return to Bristol. Defence economies led to a reduction in the number of aircraft required in the long term, and the number of aircraft to be given the avionics upgrade was reduced to 46. This reduction was achieved by reducing the number of CF-5As going through the programme from 23 to 13.

Lead-in trainer for the Hornet

The avionics modernisation was designed to transform the CF-5 into an airborne CF-188 Hornet simulator, and was known as the AUP (Avionics Upgrade Programme) when applied to an aircraft that had already been structurally upgraded, or as the DAR (DLIR And Rewire) when AUP and DLIR were incorporated at the same time. The avionics upgrade was a major task, and Bristol used the forward fuselage of a crashed CF-5B as a 'hot mock-up', for installing and testing systems.

Although integration of the MIL STD 1553B databus would have allowed the installation of a completely modern cockpit, Bristol Aerospace stopped short of replicating the CF-188 cockpit in every detail. Traditional analog instruments were retained, and MFDs were not fitted. A Ferranti HUD and HOTAS controls were fitted, however, and great attention was paid to providing Hornet-type symbology in the new HUD. The avionics package also included a Litton LN-93 laser gyro, a GEC digital air data computer, a Conrac AoA sensor, a Sundstrand accelerometer, a Jet Electronics standby attitude indicator, a TEAC video recorder, a Cardion video monitor and a Magnavox AN/ARC-164 UHF radio.

The company offered an even more wide-ranging avionics upgrade (together with the full structural modifications) to export customers under the designation Tiger 2000. This

would add cockpit MFDs, a laser rangefinder, new RWR and ECM equipment, and compatibility with a range of new-generation weapons. The company also offered a modest but effective package of performance enhancements designed by Eidetics, with low-drag outboard underwing missile launch rails, an enhanced manoeuvre flap system (giving a 30 per cent improvement in sustained turn rate) and enlarged wingroot strakes (increasing lift and instantaneous turn rate by 50 per cent).

It is uncertain as to how many of the original 23 CF-5As actually went through the structural upgrade. It may only have been the 13 aircraft that were subsequently modernised. All of the original 33 CF-5Bs were structurally upgraded, but 10 of these were not subsequently modernised (one of which crashed before AUP could be incorporated). As far as can be ascertained, only 36 aircraft (all 13 CF-5As and 23 CF-5Bs) were fully upgraded.

CAF budget crisis

Shrinking defence budgets and a current commitment to an C\$800 million reduction in spending per year have had a dramatic effect on the CAF, leading to a 25 per cent reduction in the front-line strength of the Fighter Group. A government study showed that the CF-5 was the costliest aircraft to operate in the inventory, at C\$9,500 per flying hour, although quite how this figure had been arrived at was not revealed. This revelation killed off the justification for the CF-5 as a lead-in trainer. In a time of such financial stringency it made no sense to operate an advanced trainer more expensive to fly than the front-line aircraft for which it was preparing pilots.

Although the AUP was virtually complete, and despite the fact that 419 Squadron was actually operating upgraded aircraft, it was decided to retire and sell the CF-5As. The squadron ceased operational flying in March 1995, and delivered its last aircraft to Trenton for storage. This marked the end of the line for Canadian Freedom Fighters, with a handful of AETE pilots conducting the last test and ferry flights of the final aircraft to emerge from the upgrade programme. The last AUP upgraded CF-5 was redelivered to the CAF (for storage) in December 1995, and now awaits resale, together with its companions.

Bristol's work on the CAF CF-5s gave it a great lead over most companies operating in the F-5 upgrade field, and its structural work, in particular, was soon recognised as being superior to the SLEP and SUP programmes sketched by Northrop itself. This has led to the company undertaking structural work on behalf of a number of other companies, or supplying its wingsets for use in other upgrades. Norwegian, Thai, USAF, USN and Venezuelan F-5s have all benefited from Bristol's F-5 expertise and the company has earned itself a place on Northrop's Tiger IV upgrade team.

Bristol Aerospace was also contracted to upgrade Spain's F-5s, in conjunction with CASA. The Spanish company had previously started to undertake a limited upgrade, with a minor reinforcement of the wingroot and a limited avionics improvement. The latter provided VIR-31A VOR/ILS, AN/ARC-164 UHF radio, and a new AN/APX-101 IFF. An accident in which an SF-5B lost its wing led to the real-

isation that a more comprehensive upgrade would be needed if the aircraft were to serve on, and Bristol Aerospace was called in. The full upgrade (carried out by CASA's maintenance division at Getafe using kits from Bristol) had wing modifications, a steel dorsal longeron, a new spar 325 (the aircraft being cut in half for this to be fitted), and incorporated a new undercarriage made from stronger, lighter materials. Engines and ejection seats were overhauled and zero-houred, and the avionics improvements from the original CASA upgrade were fitted. The number of aircraft to be upgraded was reduced to 22 when another two-seater was lost.

Tiger-PAWS

Another upgrade involving Bristol was the Sierra Technologies Tiger-PAWS (Program for Avionics and Weapons System improvements) modernisation for Norway, although Sierra had originally envisaged Fokker Aircraft Services at Woensdrecht carrying out all of the structural work. Sierra entered the avionics upgrade market in 1986 with a contract to develop a possible digital avionics upgrade for the USAF's fleet of T-38 trainers, while retaining compatibility with remaining unchanged systems. Sierra recommended a digital core, with MIL STD 1553 databus, a central air data computer, F-16-type HUD and a laser INS. The company then integrated weather radar, a digital FMS and EFIS cockpits into the T-38Ns used by NASA for astronaut proficiency training.

Sierra Technologies used a similar digital core concept in designing the Tiger-PAWS upgrade for the F-5. The basic Tiger-PAWS package was selected by Norway. The best 15 (seven F-5As and eight F-5Bs) were chosen to be structurally upgraded and fitted with modern avionics which would allow their cockpits to better replicate that of the F-16. Bristol Aerospace undertook a limited structural upgrade, with new dorsal longerons and new wings, while the avionics upgrade by Sierra Technologies was centred around a MIL STD 1553 databus and also included the incorporation of a GEC-Marconi HUD/WAC (a modified version of the unit used in the F-16) and MSADC (miniature standard air data computer), a Litton LN-93 ring laser gyro INS with a new AoA sensor, a video camera/recorder and HOTAS controls. Primary flight instruments were relocated to ape the panel layout of Norwegian F-16s.

Sierra is advertising similar upgrades to other F-5 operators, offering to replace the ageing analog radar fitted to current F-5Es with modern pulse-Doppler radars. The company can also offer radar for presently non-radar equipped F-5As and F-5Bs. The Tiger-PAWS upgrade can



include data transfer equipment, advanced RHAWS and ECM, chaff/flare dispensers, FLIR, laser rangefinder equipment, and single or dual cockpit MFDs, as well as the features of the Norwegian upgrade.

'El Tigre'

During 1990 Chile signed a contract with IAI to design an upgrade for its 12 F-5Es and two F-5Fs. IAI would convert the first two prototypes, then supply kits and technical assistance to allow subsequent upgrades to be carried out by ENAER in Chile. Two F-5Es (805 and 809) were despatched to IAI Bedek's Shaham Aircraft Maintenance and Upgrading Plant at Ben Gurion. The upgrade was confined to the aircraft's avionics systems, with no airframe or engine improvements. The modernised 805 made its maiden flight in what IAI dubbed Tiger III configuration on 8 July 1992.

The first F-20 prototype, repainted dark grey overall, loses off an AIM-9P Sidewinder. With its F-5E style nose, radar and canopy, the aircraft was effectively the original F-5G-1 prototype, although it did incorporate some of the more advanced systems intended for the F-5G-2.

A rare view of all three Tigersharks. The new canopy and nose shape can be seen on the top and middle aircraft.





Above: The TigerEye's nose could accommodate dedicated night reconnaissance sensors, and at least one aircraft for Saudi Arabia was delivered in an overall matt black colour scheme, leading to the inevitable jokes that this was a 'poor man's SR-71'. The RF-5E retained the port M39 cannon for self-defence, with an ASG-29 lead-computing optical sight. Radar was not fitted. The second cannon was deleted to make room for avionics equipment displaced from the nose. All external pylons were retained, including the wingtip Sidewinder launch rails.

Top: Despite the recent delivery of BAe Hawk 208s, MiG-29s and McDonnell Douglas F/A-18Ds, the F-5E's place in Malaysian service seems secure, at least in the short term, and with at least one squadron. Malaysia's fleet of F-5s (known as M29s in RMAF service) includes two RF-5E TigerEyes, and Malaysia has yet to acquire a replacement for these reconnaissance aircraft. Malaysia is said to be looking at the possibility of upgrading its F-5Es, perhaps to a similar standard to the modernised Singaporean Tiger IIs. Alternatively, Malaysia may decide to convert more of its F-5 fighters to TigerEye configuration.

The core of the upgrade was provided by a MIL STD 1553 digital databus, which allowed the installation and integration of various new equipment. Most important was an Elta EL/M-2032B multi-mode pulse-Doppler radar, derived from the radar designed for the IAI Lavi. Despite having to reduce the size of the ultra-low sidelobe planar array antenna to fit inside the F-5E's fuselage, Elta was able to maintain radar performance. In trials, astonishing results were obtained. Flying side by side with an F-16 at 5,000 ft (1524 m), the EL/M-2032B-equipped F-5 was consistently the first to detect a Kfir target flying at 500 ft (152 m), while its lower frontal cross-section allowed it to detect the F-16 first in a head-on engagement at the same height. In order to accommodate the radar and its associated LRUs, the port M39 20-mm cannon had to be deleted. During trials the second cannon was replaced by telemetry equipment, but in service the aircraft retain one cannon.

Chilean avionics choices

The modified cockpit was dominated by an El-Ops wide-angle HUD with an upfront controller, and by a pair of monochrome MFDs. IAI offers colour MFDs as an option, but Chile opted for cheaper, brighter monochrome screens. Centralised computing allowed data from all systems to be integrated onto a single integrated tactical situation display (usually presented on the right-hand MFD). This synthetic display can combine radar and RWR inputs on a synthetic picture of the ground, with borders, water, active radars, threat zones and other features incorporated. This dramatically improves pilot situational awareness and reduces head-down time. The port MFD usually presented a raw radar display (air-to-air), or aiming imagery (air-to-ground).

The new cockpit incorporated a new Aeronautics (Israel) modular mission and display processor, HOTAS controls and an improved WDINS. The new navigation suite, using GPS and INS, allowed a very accurate video debrief facility, similar to that provided on an ACMI range but without the need for ground equipment. The aircraft had a fully-integrated EW suite with RWR, ECM jammer and chaff/flare dispensers, probably using the indigenous ENAER Caiquen RWR and ECLIPSE chaff/flare dispensers. Chilean F-5Es can also carry an IAI reconnaissance pod, but it is not known how many such pods have been supplied, nor are details of their equipment known.

The upgraded Tiger III has provision for low-drag outboard underwing pylons compatible with the Rafael Python 3. Considerably larger and heavier than the Sidewinder, the Python retains IR guidance but has a larger 24-lb (11-kg) HE fragmentation warhead and an advanced active radar fuse, giving greater lethality. The highly sensitive seeker has an increased look angle, giving greater off-boresight capability.

The first IAI-modernised F-5E was returned to Chile in July 1993, and all have now been returned to service. It has not yet been revealed whether the 12 F-5s acquired from Honduras will undergo the same upgrade, but this is likely.

IAI is offering its upgrade to other F-5 operators, and can add many other features not specified by Chile. Such features include an inflight-refuelling probe, a helmet-mounted target designator, secure radios, a new air data computer and even a new ejection seat.

Singapore Aerospace

Israel has also been heavily involved in upgrade work carried out in Singapore. After upgrading Singapore's fleet of A-4 Skyhawks, Singapore Aerospace participated in the modernisation of New Zealand's A-4s. The success of these programmes led to the award of a contract for upgrading 35 Singaporean F-5Es and F-5Fs in association with Israel's Elbit. The exact nature of the upgrade applied to Singapore's own F-5Es is unknown, but incorporates some elements of the three-stage modernisation now being offered to other customers. For the first stage, the Elbit-integrated avionics suite included the provision of a new HUD, with upfront controller, a new air data computer, a digital mission computer, ring laser gyro INS, HOTAS controls, and a colour HUD video camera. The second stage added a FIAR Grifo F/X Plus radar, as used in the AMX. This had 10 air-to-air and 14 air-to-surface modes, and was AMRAAM- and SARH missile compatible with minimal modification. It also added VOR/ILS, TACAN and radar altimeter, plus one or two colour or monochrome MFDs, as well as a data transfer system. The MIL STD 1553B architecture allowed for the addition of FLIR, ECM and advanced RWRs as a third stage.

Singapore Aerospace carried out a much more modest upgrade for Venezuela. The delivery of surplus Dutch NF-5As allowed Escuadron de Caza 36 to resume flying, while the 14 survivors of the original CF-5As and CF-5Bs (grounded since 1990) were upgraded. The first two were modified at Paya Lebar between May 1991 and May 1993, when they returned to Venezuela. The rest were upgraded from 1994. Malaysia, Morocco and Tunisia are also targets for a fuller Singapore Aerospace upgrade, all three nations having expressed interest in retrofitting their F-5Es and F-5Fs with the FIAR Grifo F/X Plus radar.

Northrop Tiger IV

Northrop was a latecomer to the upgrade market. During the mid-1980s the company was still aggressively marketing the F-20, which aimed to replace F-5s, and offering an upgrade would only have been an unwelcome distraction. The eventual failure of the Tigershark, the dramatic cutting back of the B-2 programme and the cancellation of the

YF-23 in favour of the F-22 left Northrop short of military work. The upgrading of F-5s offered a potentially lucrative source of work which could no longer be left to others.

Despite having initially left the field clear for competitors, Northrop claimed to enjoy several unique advantages over the opposition. As the Original Equipment Manufacturer (OEM), Northrop claimed a unique level of F-5 experience and expertise, with a unique database and with access to comprehensive analytical tools. Its status also made it the most qualified contractor for the certification of modifications and repairs, while recent experience on the B-2 and F/A-18 had given the company experience of the most modern avionics and systems. The avionics integrator on the B-2 and the original F-5 manufacturer was clearly the best choice for avionics integration on F-5 upgrades, the company implied.

USAF SUP contract for Northrop

Northrop's primacy was reinforced by the 16 March 1995 award of the F-5/RF-5 SUP (Structural Upgrade Programme) contract by the USAF's San Antonio Air Logistics Center (SA-ALC), the Kelly AFB-based unit responsible for supporting FMS and MAP F-5 customers. This contract covered the design, development and prototyping of upgrade packages, and production of kits and installation as required. The basic SA-ALC approved package consisted of redesigned forward fuselage lower longerons, composite fuselage fairings, new horizontal stabiliser leading edges, and new dorsal longerons for all models and new wings. The package also included a new wing for the F-5E/F, compatible with AGM-65, and new intake ducts and bulkheads for F-5A/B models. The contract was estimated to have a potential value of \$172,678,905.

The SUP very much represented the minimum necessary upgrade, and Northrop could see a huge market for a more ambitious upgrade, with further structural improvements and a major avionics modernisation. Recognising the advantages of working with a formally established team of avionics suppliers, Northrop assembled a Supplier Team within what it called the F-5 Worldwide Team, which also included Bristol Aerospace and airframe companies (CASA and Samsung Aerospace) from two potential customer nations, Spain and Korea. The inclusion of Bristol Aerospace was particularly noteworthy, since many independent analysts rate the Canadian company as being the leading F-5 structural experts, and since the two companies were locked in a legal struggle until comparatively recently.

On 11 November 1993 Northrop announced that it had signed a memorandum of agreement with the US Navy under the terms of which it would structurally modify and integrate new avionics into a US Navy F-5E, at no cost to the US government. The contract for this agreement was actually signed with the USAF's San Antonio Air Logistics Center, and marked the start of a Cooperative Research

and Development Agreement (CRDA). This was not a procurement contract, nor did it even constitute a USAF endorsement of the proposed Northrop upgrade, although General Ronald W. Yates, commander of USAF's Air Materiel Command, described the CRDA as giving industry "the opportunity to qualify a design in anticipation of possible future business. Once an item is qualified, we provide maximum visibility to proven and viable worldwide customers."

The new avionics suite included an APG-66(V) radar, Honeywell ring laser gyro, AlliedSignal mission computer and display processor, new MFDs, Fairchild Defense data transfer equipment, an F-16-type GEC HUD, and HOTAS controls, while the aircraft was also fitted with a Martin-Baker Mk 10LF seat. All equipment (apart from the radar) was competitively selected, and all subcontractors provided their equipment at no charge. According to early press reports, the nine-month upgrade was due to begin with delivery of the aircraft to Northrop's El Segundo facility in January 1994. The original plans were then reportedly for the aircraft to return to NAS Fallon for flight tests, with the first 10 flights being performed by Northrop pilots, and the rest by US Navy pilots.

Tiger IV slips its leash

In the event, 74-1568 was not delivered to Northrop until June 1994, and then to LA International Airport, adjacent to the company's Hawthorne facility. After modification it did not return to the squadron, but instead was retained by Northrop as the Tiger IV demonstrator. 74-1568 made its maiden flight in modernised form on 20 April 1995. It then flew to Edwards AFB for testing, in what was anticipated to be a 31-flight programme. The aircraft retained its '46' adversary nosecode, but lost the 'NJ' tailcode and VFA-127 titles on its centre fuselage. Instead, the aircraft received a huge TIGER IV logo on the tailfin (with a tiger's head superimposed) and the legend 'F-5E TIGER IV' on each side of the rear fuselage, above the wingroot.

Bottom: The first of three specially decorated CF-5As operated by 419 Squadron, the last Canadian operators of the Freedom Fighter. After a costly and comprehensive upgrade, the CF-5 fell victim to budgetary cuts and was retired from service. The aircraft were placed in storage and are currently for sale – the most lavishly equipped and structurally sound F-5s on the market.

Below: Chilean F-5Es wear the two tiger's heads insignia of Grupo 7 on their tailfins, and operate in the air defence and ground attack roles. Long years of international isolation and arms embargoes forced Chile to develop a highly capable indigenous arms industry, and to forge close links with other pariah nations like South Africa and Israel. This F-5E is seen with a display of indigenous Cardoen bombs, which were probably jointly developed with Israel. With isolation now at an end, Chile has been able to boost its F-5 fleet by absorbing the aircraft formerly used by Honduras.





Above: Until quite recently, regulations were in force to ensure that ex-USAF and USN aircraft were demilitarised before disposal. This was usually ensured by cutting through the main spar. More recently things have been relaxed, and Chuck Thornton has successively owned T-38s and F-5s which he leases out for a variety of test and film work.

Top: NASA has operated a single F-5F from its Langley facility since August 1989. The aircraft was previously used by the 425th TFTS.

Below: Northrop's Tiger IV demonstrator was borrowed back from the Navy's VFA-127. The USAF's San Antonio Air Logistics Center has made it clear that other upgraders could receive F-5Es to use as prototypes subject to forming the same kind of teams.

The aircraft did not incorporate all of the equipment intended for the upgraded Tiger IV, but was quite comprehensively modified and modernised. In the cockpit, for example, twin MFDs flank the upfront controller for the new GEC HUD, giving the aircraft the most modern and most user-friendly cockpit yet seen in an F-5. The cockpit incorporated HOTAS controls by Mason Electric, adapted from the F/A-18. In order to accommodate the AN/APG-66(V) radar (as used in the F-16 MLU), the nose bulkhead was moved aft by 20 in (50 cm) and the radome was lengthened. One of the two M39 cannon was removed to make space for radar LRUs, and the other to accommodate temporary test and recording equipment.

Other members of the Supplier Team were AlliedSignal who supplied the air data computer, Base 10 who supplied the SMS and Litton who provide the OBOGS and airborne video camera. Moog Esprit provided the armament control unit, nav/com the radar altimeter, Teac America the video recorder, and United Technologie/Hamilton Standard the environmental control system.

This leaves some equipment unallocated, and the exact final content of the different levels of Northrop's Tiger IV upgrade is still undecided. In November 1995, for example, Northrop was still negotiating with Dassault Electronique for the use of the EWS-A Aigle RWR. Nevertheless, the use of a MIL STD 1553 MUX bus and modular software has allowed Northrop to describe possible improvements in levels. The bus and modular software compatibility represent the first level, while level 2 comprises the HUD, INS, APG-66 radar, a single MFD display and the air data com-

puter. Level 3 adds HOTAS, an advanced weapon delivery system, and the mission computer, while Level 4 gives a new instrument panel with dual MFDs, advanced TACAN and a data transfer system. Above these formal levels are a host of options, including FLIR, advanced RHAWS, ECM and a laser designator.

Future upgrade candidates

Northrop-Grumman and Samsung have teamed to rewing an initial batch of 27 F-5Bs used in the training role. They hope that this will give some advantage in the closely-fought battle to fulfil Korean requirements for an upgrade for its 200-plus front-line F-5Es and F-5Fs, for which the full Tiger IV is a leading contender.

Brazil is likely to sign an upgrade contract in 1996, covering the upgrade of at least 50 of its surviving F-5Es and F-5Fs. Avionics are likely to be based on those selected for the indigenous Tucano-derived ALX and for the Italo-Brazilian AMX, probably including FIAR Grifo or Tecnasa SMA SCP-01 radar and an OMI/Alenia HUD with a HUD/WAC and MIL-STD 1553B databus, NVG-compatible cockpit and chaff/flare dispensers. A teaming of Northrop and EMBRAER would seem to be the most likely favourite to win the Brazilian contract.

Israel's IAI and Elbit proved that not being an F-5 operator does not rule one out as an F-5 upgrader. The Belgian company SABCA has specialised in modification and modernisation work, being too small for full manufacturing. The company has recently upgraded Belgian air force Westland Sea Kings, for example. Belgian defence cuts led to the sale of the radically modernised Mirage 5s upgraded for the Belgian air force by SABCA before they could re-enter service. The aircraft were subsequently sold to Chile as Elkans, with some further modifications. This situation gave SABCA useful experience of the problems inherent in fighter upgrades, with avionics integration and simultaneous structural refurbishing of ageing airframes, and launched the company on the overseas upgrade market.

Belgium and Indonesia

In March 1995 SABCA was chosen to upgrade 12 F-5Es and F-5Fs for the Indonesian air force under a \$40 million contract. A single F-5E and an F-5F are being upgraded by SABCA at Gosselies as part of a 20-month 'prototype' phase, prior to the supply of upgrade kits which will allow the remaining aircraft to be modernised (with Belgian assistance) in-country. The Belgian upgrade for Indonesia is centred around the installation of a MIL STD 1553 digital databus, with a new air data computer, a new stores management system, and a radar upgrade (the Emerson APG-159(V)-3 radars will be upgraded to (V)-5 standards). The aircraft will also be fitted with a GEC-Marconi Avionics HUD/WAC and a Sky Guardian RWR.

Perhaps the most ambitious F-5 upgrade was Taiwan's proposed F-5E-SX. This would have replaced the twin J85 engines with a single F125X (as used by the indigenous Ching-Kuo) or J101 turbofan and would have added a new multi-mode radar, perhaps the indigenous Sky Dragon derivative of the AN/APG-67. Combined with AIM-120



and Sky Sword missiles, this would have transformed a standard F-5E into something approaching (or exceeding) the F-20 Tigershark. It now seems likely that any upgrade for the Taiwanese F-5Es will be more modest in scope.

New teeth, new claws

It is not just airframe and avionics companies who are jumping on the F-5 upgrade bandwagon. The main weakness of the basic F-5A and even of the F-5E was the type's limited range of weaponry, and incompatibility with the latest generation of precision-guided weapons. During late 1995, GEC-Marconi fit-checked the 227-kg (500-lb) PGM-500 on the F-5E Tiger IV demonstrator. The weapon is a derivative of the Al Hakim family of guided ASMs developed for the UAE. Laser designators being marketed for use on the F-5 include the Thomson-CSF ATLIS and the Rafael Litening.

Daimler-Benz Aerospace (through its Florida-based CMS subsidiary) has fit-checked the AFDS (autonomous free-flight dispenser system) on the F-5 and is offering the weapon to potential customers. The INS/GPS-guided dispenser has a range of about 8 km (5 miles) when released from low level, or 22 km (14 miles) when dropped from an altitude of 20,000 ft (6096 m).

Not restricted to use by modernised F-5Es is the General Electric GPU-5/A 30-mm gun pod, carried under the centreline. The GPU-5/A Pave Claw contained the four-barrelled GAU-13/A derivative of the A-10's GAU-8/A Avenger cannon and could fire at rates of up to 2,400 rpm. This was first cleared for use by the F-5 in March 1979 when Rich Richins completed the last of 13 flights at Edwards AFB. With the gun pod fitted, the aircraft "handled the same as a regular F-5E carrying a centre fuel tank," according to Richins, who added that the new gun "seemed to track well, with the rounds going exactly where the pipper was aimed." When later adapted for use on the F-16As of the New York ANG, the GPU-5/A proved disappointing, especially during Operation Desert Storm. This revealed poor integration with the aircraft's gunsight and a lack of rigidity in the pylon mounting, which gave poor accuracy, although the Desert Storm test was perhaps not a fair one involving, as it did, firings from higher altitude than had been anticipated. GPU-5 has been exported to Thailand for its F-5Es, where it has proved more successful.

Because most of those nations retaining the F-5 are keeping it for use in the air-to-ground or advanced training roles, or are too poor or too unreliable to be offered the AIM-120, most upgrades are concentrating on improving close-in dogfighting capability, with new radars, HOTAS controls, wide-angle HUDs and extra missile pylons. Israeli upgraded aircraft offer compatibility with the Rafael



Python and Shafir AAMs. These two weapons are indigenous Israeli IR-homing AAMs and are broadly equivalent to the AIM-9 Sidewinder, although the Python's larger airframe gives it a more lethal warhead and longer range, while its seeker is claimed to have better discrimination and wider 'look' angles. It can be used in conjunction with an Israeli-developed, helmet-mounted target designator, giving a formidable off-boresight capability.

Despite its many strengths, the F-5 is not proving to be a very desirable aircraft at the moment. At the time of writing Bristol Aerospace had been unable to sell a single example of the CF-5s they had upgraded, and the only customers for refurbished F-5s seem to be existing operators, cut off from newer fighter types by funding constraints or arms embargoes. This lack of demand would almost certainly make the F-5s currently for sale a great bargain. Unfortunately, the politicians who control the purse strings are unlikely to be tempted by a 'bargain' without a specific requirement, and few military procurement officers would risk priority frontline programmes by pressing for a new auxiliary air force fighter, or for an extra tactical training aircraft. In any case, in each of these potential roles, the F-5 is bettered by more modern rivals, whether they be refurbished early-model F-16s or brand-new MiG-29s or Hawk 200s. The only advantages offered by the F-5 are cost and, for the existing operator, commonality. However, many existing operators have invested heavily in their F-5s, and have received, in return, a flexible, versatile and competitive lightweight fighter. The upgraded F-5 is a potent machine, and should not be written off lightly.

Jon Lake

The upgrade to Norway's surviving F-5s, carried out by Sierra Technologies, optimised the aircraft for use as lead-in trainers for the F-16, and not for any operational role. The advanced training role is becoming an increasingly popular use for the F-5, the aircraft offering a useful stepping stone between trainers like the T-38 or Alpha Jet and the latest frontline operational fighters.

It is still far too early to start writing obituaries for the F-5. Ambitious avionics upgrades and comprehensive structural reworks have been applied to many aircraft, fitting them for continued service into the next millennium. 1995 did mark the sunset of this particular Norwegian F-5A, however, since it was not one of those selected to receive the Tiger PAWS upgrade.



Northrop F-5 Operators

Bahrain

Bahrain Amiri Air Force

The Emirate of Bahrain is an island state (more correctly an archipelago) which holds a strategic position in the Persian Gulf, between Saudi Arabia and the Qatari promontory. It gained its independence from Britain in 1971 and, under the auspices of the Gulf Co-operation Council, quickly established a small defence force. A pre-existing para-military air arm, equipped with helicopters, was formally established as the Air Wing of the Bahrain Defence Force in 1976 and, as part of its expansion plans, an application was made to the United States for a package of aircraft and missiles, including the F-5E. This application was refused by the Carter administration but, in 1982, with nearby Iran and Iraq at war and President Reagan installed in the White House, Bahrain reapplicated for US assistance.

Bahrain requested the F-20A Tigershark (four), F-5Fs (two) and 60 AIM-9P-3 Sidewinders, in a package then worth \$180

The small Bahrain Amiri Air Force has relied on the F-5 over 10 years, but the prospect of further F-16 deliveries most likely spells the end for the Emirate's F-5Es. The F-5s are now based at Shaikh Isa AB.

million. The US declined to offer the F-20, as Bahrain's small requirement was not enough to launch the project and, instead, the F-5E was acquired in a \$92 million purchase, in 1985. Eight F-5Es and two F-5Fs were delivered, along with 60 Sidewinders, between December 1985 and January 1987. The last two F-5Es were the final F-5s to be supplied to any customer under the FMS programme.

The Tigers were the sole combat aircraft (indeed the sole fixed-wing type) flown by the Bahrain Amiri Air Force and were based at Manama Airport, on the island of Muharraq. With US assistance a massive new air base, Shaikh Isa AB, was constructed (beginning in 1987) on the main island of Sitra and the F-5 force moved there upon its completion.



In March 1990 the first of 12 F-16C/Ds arrived at Shaikh Isa, to supplement the five surviving F-5s. Bahrain is now considering an offer of 18 former US Navy F-16Ns to

replace its F-5s, as a result of Bahrain's aid to the coalition forces during the Gulf War of 1991. The USN officially retired its F-16Ns in January 1995.

Brazil

Força Aérea Brasileira

Brazil expressed an interest in the F-5 in the late 1960s. In 1967 the previously reluctant United States sanctioned a sale once it became clear that the FAB would acquire high-performance combat aircraft in the shape of the Mirage IIIIB. The deal fell into abeyance, but in 1975 Brazil did become an F-5 operator, and the first export customer for the F-5E, with the arrival of the first of 42 aircraft, ordered in 1973. Between March 1975 and February 1976, 36 F-5Es and six F-5Bs were delivered in a package worth \$111 million. The F-5 is one of the few FAB aircraft which does not have a local designation, and all aircraft wear their model designation on the fin. The Tigers entered service with COMAT (Comando Aerotático - Tactical Air Command) and were based at Santa Cruz. The Brazilian air force has a standard squadron (Esquadrão), group (Grupo), wing (Grupo de Aviação/air wing) establishment and so the F-5s were allocated, in two mixed squadrons of F-5E/Bs, to the 1º GAvCa (Grupo de Aviação de Cacá/Fighter Aircraft Wing). This unit is the famous No. 1 Fighter Group 'Senta a Pua', which flew P-47Ds alongside the Allies in Italy during World War II.

During the late 1980s Brazil considered several options for increasing its combat aircraft fleet. The AMX project was already underway to answer some of these needs but the prospect of a massive Chinese order for EMBRAER Tucano trainers lead to the evaluation of the Chengdu F-7 by the air force. Interest then switched to the acquisition of 14 F-5s from the Chilean air force, along with additional Mirage IIIs from other sources. Even former Belgian/Dutch F-104s were considered before Brazil opted for an offer of 23 refurbished F-5Es and three F-5Fs from the United States (a mix of those formerly operated by the 425th TFTS, at Williams AFB, and the 57th TTW at Nellis AFB). They began to arrive in October 1989 and entered service with 14º GAVCA, at Canoas AB. Some of these were former South Vietnamese aircraft and at least one

(4858 c/n R.1004) was built as an RF-5E. Today the F-5s still serve with their three original squadrons: 1º Esquadrão do 1º Grupo de Aviação de Defesa (Air Defence Wing), and both 1º and 2º Esquadrão do 1º Grupo de Aviação. Each squadron also operates a number of EMBRAER AT-27 Tucanos for refresher training.

Brazil has a sizeable weapons design and manufacturing capability, aided by a 1984 agreement with the USA for technical assistance in return for a reduction of exports to the Middle East (Brazil was a major supplier of rocket artillery to Iraq, for example). This has led to the development of the MAA-1 air-to-air missile for the Mirage III, F-5 and AMX. The MAA-1, known variously as Piranha and Mol (by the



This 1º GAvCa F-5B (above) carries a centre-line target winch, while the grey Canoas-based F-5E (left) is one of 14º GAV's ex-USAF aggressor aircraft delivered in 1988.



air force), is an early-model AIM-9 lookalike, but with a wider body. It has an all-aspect IR detector (with a ±40° look angle), a 12-kg (26-lb) HE warhead and a range of 5 km (3 miles). Development began in the late 1970s and trial firings were undertaken in 1986/87. It was reported that the Mirage III, at least, has been equipped with the MAA-1, but photographic evidence of it on an F-5 is elusive. Development funding was halted by the government in 1988, but it has been restarted and reports suggest that the

missile could still enter service in 1996. The F-5s are usually equipped with wingtip AIM-9P Sidewinders.

Avibrás has developed its own range of general-purpose bombs, including the 250-lb AV-BAFG-120 (based on the US Mk 81) and the 500-lb AV-BAFG-250 (based on the US Mk 82). Napalm canisters are another FAB favourite. Unguided rockets for the F-5, also built by Avibrás, include the 37-mm SBAT-37, fired from a seven-round LM37/7 launcher, 70-mm SBAT-70 (M1, non spinning) fired from a variety of launchers (from two- to 19-round) and the 127-mm SBAT-127 (based on the US 5-in Zuni Mk 16), with a 20-kg (44-lb) HE warhead (fired from a two-/four-round launcher).

Brazil's F-5 fleet has been much modified throughout its service life. Most of the original batch of aircraft have been fitted with a bolt-on refuelling probe (to starboard), for use with the air force's KC-130 and KC-137 tankers. The US supplied unspecified upgrade kits during the 1980s. The ex-USAF F-5Es obtained during the 1980s are dedicated air defence aircraft and retain an overall-grey scheme (a legacy of their days with the 425th TFTS), although

Today's 1º GAvCa can trace its heritage back to 18 December 1943. It subsequently served in Italy as the 1st Brazilian Fighter Squadron, equipped with P-47Ds.



they operate alongside camouflaged F-5s from the earlier batch. The older F-5s wear a three-tone brown and green scheme. Some F-5s (chiefly those at Canoas) now wear a USAF-style, two-letter base code on the fin, a marking system which is currently undergoing evaluation with the FAB.

In 1996 the FAB will award a contract to upgrade 51 F-5E/Fs, a task that is to be completed by the year 2000. A contractor has not been chosen, but the avionics fit will be governed by that chosen for EMBRAER's ALX, plus a new multi-mode radar that is not required by the Tucano development. ALX, a development of Tucano H, will be fitted with a HUD/WAC, air data computer, GPS and INS, RWR, chaff/flare dispensers, MIL-STD 1553B databus and an NVG-compatible cockpit.

III Força Aérea, Brasilia

Unit: 1º GAvCa

Base: Santa Cruz AB

Tailcode: 'SC' (not yet worn)

Component squadron: 1º Esquadrão (1º/1º GAvCa)

Nickname/callsign: Jambock

Squadron markings: Group badge of revolver-toting ostrich standing on clouds, holding a blue shield with five stars. All on a circular red background, with the motto 'Senta a Pua!' ('Give it Hell')

Component squadron: 2º Esquadrão (2º/1º GAvCa)

Nickname/callsign: Pif Paf

Squadron markings: as above

Unit: 14º GAV

Base: Canoas AB

Tailcode: CO

Component squadron: 1º Esquadrão (1º/14º GAV)

Nickname/callsign: Pampa

Squadron markings: Blue fintip band with five stars (four large, one small, in centre)

Canada

Canadian Forces/Forces Canadiennes

During the early 1960s, in parallel with the USAF's search for a new lightweight fighter, Canada was searching for a CF-104 replacement for its own air force. Competing for this order was a wide (some might say bizarre) range of aircraft which included the Fiat G91, Douglas A-4, McDonnell F-4 (J79- and Spey-engined versions), Rockwell A-5A, Grumman A-6A, Vought A-7A Corsair, Republic F-105, North American F-100S (a proposed Super Sabre upgrade), North American F-107A and General Dynamics F-111A. In July 1965 the F-5 was pronounced as the winner, in contrast to the USAF which opted for the A-7. The A-7 was allegedly the runner-up in the Canadian competition. The F-4 was the CAF's preference, but the US was reluctant to release it, or other 'advanced' types, for the licence-building agreement on which the Canadian government insisted.

The F-5 was selected principally on grounds of cost and was certainly far from the air force's favourite option. Canadair would build all the aircraft acquired, but for a nation with a sophisticated aviation industry, which had produced the world-beating CF-105 Arrow, the F-5 was a decidedly retrograde step. The F-5's two General Electric J85 engines would be licence-built by Orenda, a company which had played a vital part in the ill-fated Arrow story, building the PS-13 Iroquois engine.

The Canadian requirement for 200 aircraft translated into an order for 125 CF-5s (a mix of single-seat CF-5As and two-seat CF-5Ds - D for Dual) in September 1965. By 1967, inflationary pressures had reduced this to 89 CF-5As and 26 CF-5Ds. The Canadian programme designation for the F-5 was CL-219 and host of modifications was incorporated in its production aircraft. Provision for a detachable refuelling probe was made on the starboard side (unlike the US version) and jettisonable underwing pylons were added. The windscreens were strengthened to protect against birdstrikes and both it and the engine inlets were wired for deicing. A clever modification to the nose gear allowed the leg to be raised by 3° (or 1 to 1½ in/2.5 to 3.8 cm) for take-off, increasing the angle of attack of the wing and thus improving take-off performance (by lowering the take-off speed). Performance was also aided by uprated J85-CAN-15 engines, developed by Orenda, which required louvred intake doors above the wing trailing edge. Furthermore, up to four JATO bottles could be fitted to the CF-5. An arrester hook was added and the onboard electrical systems were nearly doubled in power output. The cockpit avionics were substantially revised and a Ferranti ISIS lead-computing gunsight fitted. A new nose-mounted reconnaissance package was designed.

Canadair's prospects were boosted by the Dutch decision, in 1967, to purchase 105 F-5s from its production line. Northrop repainted an F-5B (the eighth production aircraft) to act as a demonstrator for Canadair. Despite this, Holland remained Canadair's only export customer until virtually the end of the CF-5's production life, when some surplus aircraft were delivered to Venezuela. Canada had planned to establish four CF-5 units – three active and one training squadron (down from six originally). However, a reduction in the country's NATO commitment saw this reduced to one front-line and one dual-role active/training squadron. As a result, 55 CF-5s, once destined for the CAF, were delivered directly to storage.

The first CF-5 (14701, in the old-style sequential RCAF serial system) was rolled out at Canadair Plant 2, Cartierville on 6 February 1968. On 8 February it was flown, onboard a CC-130, to Edwards AFB for check-out by Northrop. There, the first CF-5 (newly reserialled 116701) made its maiden flight on 6 May 1968. Sadly, 701 crashed at Edwards on 3 December 1969. The second aircraft was also flown to California for evaluation by Northrop, but the third production CF-5, the first CF-5D, flew in Canada on 28 August 1968.

On 1 February 1968, the Royal Canadian Air Force was merged with the other

Right: Illustrating the old and new colours worn by Canada's CF-116s, these two 419 Sqn CF-116As are seen in 1988 wearing the original grey/green camouflage and the 'post-upgrade' wrap-around grey scheme. Note the false canopy on the fuel tank of the grey aircraft.

Below: The Cold Lake-based CF-116s wore several aggressor colour schemes, and this one was a pre-disbandment 'show' scheme.



Below: Lifting off from CFB Cold Lake, this 419 Squadron CF-116D is wearing an aluminium finish, with red trim that closely resembles the colours worn by early CF-116Ds, 20 years previously. Visible in the background are hangars used by AETE, along with the CAF's CF-188 simulator facility.



services to become an element of the tripartite Canadian Armed Forces. The only CF-5 to carry RCAF markings in the air was the Northrop demonstrator, in 1966. Until 1976 the Canadian Forces operated a confusing system of aircraft names and designations. Each aircraft had a Chief of Technical Services Designation (CF-116) and a Type Designator or popular name (CF-5). According to this system the CF-5A was a CF-116 and the CF-5D was a CF-116D; the reconnaissance-configured aircraft were never referred to by any other form of identification than CF-5A(R) – and usually only on 'tech' sheets at squadron engineering level. The 'logical' forms of CF-116A/D etc. appear here for ease of use.

Initial CF-116A deliveries to the CAF ended on 21 September 1971 (direct to North Bay, for storage) and CF-116D deliveries on 15 October 1969. In 1972 the sale of 18 stored and 'second-hand' aircraft to Venezuela provided the funds for 20 new-build CF-116Ds (18 for the CAF and two for Venezuela). The cost of converting some Canada's substantial number of stored CF-116As was virtually identical to that of reopening production. The first of these new aircraft was rolled out in September 1973 and flew initially on 23 October. CF-116 deliveries to the CAF finally ended on 31 January 1975, when 116846 arrived at Cold Lake for use with 1 CFFTS. Early CF-116Ds were delivered in an overall silver scheme but the CF-116As wore a two-tone green and grey camouflage with light grey undersides. During the 1980s a wrap-round grey/green scheme with low-viz markings was adopted. Many CF-116Ds retained their silver finish, with red trim, throughout their careers.

CF-5 Production

Service designation: CF-5A (CF-116A)
Canadair designation: CL-219-1A10
Construction numbers: 1001-1089
Serials: 116701-116789
Quantity: 89

Service designation: CF-5D (CF-116D)
Canadair designation: CL-219-1A17
Construction numbers: 2001-2026
Serials: 116801-116826
Quantity: 26

Construction numbers: 2027-2046
Serials: 116827-116846
Quantity: 20

Two squadrons (433 and 434) were both NATO-dedicated units and the CF-116's air-to-air refuelling capability allowed it to make

regular deployments to Europe. The CF-116's refuelling probe was compatible with the Beech 1800 refuelling pods as fitted to the CAF's CC-137 tankers and could accept fuel at a rate of 2,000 lb (907 kg) per minute. The first CF-116 deployment took place in October 1970, to Norway, and the first direct flight (Operation Long Leap), from Canada to Norway, took place on 6 June 1973. Each squadron undertook at least one annual deployment to Bodø, Rygge or Bardufoss (Arctic Express exercises) for approximately three weeks.

Part of the Canadair CF-5 design allowed for the rapid conversion of an aircraft to CF-5(R)/CF-116A(R) standard through the addition of the Recce Camera Control System (Type CCS-1) photo-reconnaissance nose. This camera nose could house a fan of three Vinten Model 547 70-mm cameras facing forwards and obliquely sideways. The CF-116 could also be equipped with the A/A37U-15 towed target system (comprising a 2,300-ft/701-m RMU-10/A tow reel with a TDU-10/B target dart).

When Canada began the search for its NFA (New Fighter Aircraft) in 1977 (which eventually resulted in the CF-188 Hornet), it was announced that the CF-116 would not be retired, like the CF-101 Voodoo and CF-104 Starfighter. Instead, it would be used as an interim trainer to bridge the (substantial) gap between the CF-188 and CT-114 Tutor. In the spring of 1985 the CAF completed a feasibility study for a CF-116 upgrade programme to allow the aircraft to serve as a lead-in trainer for the CF-188 Hornet. The prime requirement was to integrate a new HUD and Weapons Aiming

and Computing System (WACS), with an associated air data computer, along with an improved navaid suite and INS. The upgrade proceeded in two steps. Firstly, each airframe would be stripped down, structurally strengthened (replacing the dorsal longeron with a steel unit) and rewired to extend its 4,000-hour flying life (ultimately by another 4,000 hours). This contract was awarded to Winnipeg-based Bristol Aerospace, a wholly-owned subsidiary of Rolls-Royce. Bristol would be responsible for upgrading 46 aircraft (13 CF-116As and 33 CF-116Ds). Then, in November 1990, a second phase was authorised to include the new avionics fit. In its final form this comprised a GEC-Marconi HUD/WAC, Litton INS, Magnavox AN/ARC-164 VHF radio, JET standby attitude indicator, Conrac AoA sensor, Honeywell radar altimeter and Ferranti video camera (viewing through the HUD), all linked by a MIL-STD 1553B databus. A CAF CF-116 which had been withdrawn from use (116804, which was written off in a March 1969 crash) was used as a non-flying 'prototype', chiefly to test avionics integration.

The first so-called AUP (Avionics Upgrade Programme) CF-116 was rolled out in August 1989, but did not make its maiden flight until 14 June 1991. Deliveries commenced to the CAF in 1993. Upgraded aircraft were repainted in a wrap-round three-tone grey/blue scheme, with the low-viz markings which had been slowly introduced from 1987.

Then, suddenly, the end for the Canadian CF-116 fleet came with the 1995 Defence

F-5 Operators

Budget. That year, the Department of National Defence initiated a 25 per cent cut in the strength of Fighter Group A. A substantial portion of the active CF-188 fleet (12 of 72) was placed in storage and, to save the Hornets from further cuts, the CAF opted for the complete elimination of the CF-116 from the inventory. By April 1995 Bristol had completed 37 upgrades, spending nearly C\$76 million of a C\$79 million contract. The AUP was then suspended and no further modifications were undertaken. Approximately 80 CF-116s remain extant in Canada, and Bristol, in conjunction with the CAF, was authorised to seek customers for some or all of these. Turkey expressed an interest in acquiring the AUP CF-116s in mid-1995, but Canada insisted that any aircraft be used only for training or for defence against an external threat. To date, virtually all CF-116s remain in storage, with two allocated to Bristol for test and demonstration purposes.

434 ('Bluenose') Tactical Fighter Squadron

CF-116 deliveries to the CAF began on 5 November 1968, when 116802 was flown to 434 Squadron at Cold Lake AFB. The squadron had been activated on 15 February 1968 as the type Operational Training/Tactical Fighter Squadron, as part of the CAF's Mobile Command. Students undertook a 20-week course, including 98 hours on the CF-116A/D. 434 also trained the core of instructors for the Dutch and Venezuelan air forces. On 2 April 1976, 419 Sqn took over the operational training task and 434 became purely a Tactical Fighter Squadron. Like every CF-116 squadron, 434 maintained a four-ship display team (without special markings), the 'Schooner Bluenoses'. It alternated with 433 Squadron to cover air shows in eastern Canada.

CF-116 AUP aircraft

CF-116A (13 authorised)
116705, 116707, 116716, 116719, 116723,
116727, 116732, 116734, 116754*,
116764*, 116765, 116768, 116774
*(116754 replaced 1167704 and 116764 replaced 116715)

CF-116D (33 authorised)
116801, 116802, 116805, 116807, **116809**,
116810, 116811, 116812, **116813**,
116814, **116815**, 116818, **116819***
116820, 116821, 116823, 116824, 116829,
116830, 116831, **116832**, 116833, **116834**,
116835, 116836, 116837, **116838**, 116839,
116840, 116841, 116843, 116845, 116846
*116819 was written off on 10.1.1992 after its structural but before its avionics upgrade.

Aircraft marked in **bold** did not receive avionics upgrade.



Seen in May 1995, this post-AUP CF-116A wears the AETE's red cross on its rudder, along with non-standard Dayglo panels. AETE has responsibility for the CAF's last active CF-116s, which are used for type currency.

433 ('Porcupine') Squadron/433^e Escadron de Chasse Tactique - ETAC

433 officially reformed on 26 September 1969, at Bagotville, Quebec, and received its first CF-116 on 25 August. The 'Porcupines' were part of the CAF's NATO-dedicated 10 Tactical Air Group and were tasked with tactical strike, close air support, anti-shipping and reconnaissance, with a secondary air defence mission. 433's display team was named the 'Saguenay Quebecs'.

1 Canadian Forces Flying Training School

1 CFFTS was a CF-116 operator for two years, after it exchanged its veteran T-33s for 12 CF-116s in 1974. These aircraft were all examples from the second production

The unit was tasked with reinforcing NATO's northern flank. Based in Quebec, 433 was a French language unit and was traditionally linked with EC 1/3 'Navarre' in France. The squadron badge comprises a cartoon porcupine (drawn by Walt Kelly of 'Pogo' fame) holding a missile under one arm, and was worn, on a white disc, on the port intake only. The 'Porcupines' swapped their CF-116s for CF-188s in December 1987.

419 ('Moose') Squadron

When 434 gave up its CF-116 training role this task passed to the newly reformed 419 Sqn, also based at Cold Lake AFB. 419 became active with the CF-116 on 2 April 1976 and undertook the advanced weapons training for the type along with the annual FWIC (Fighter Weapons Instructor Course). It also maintained a display team, the 'Rut Zulus'.

419 had its origins as a World War II Wellington squadron and was the only CF-116 squadron to survive into the 1990s. As part of No. 4 Wing (from 1 April 1993), based at Cold Lake AFB, the 'Moose' provided lead-in fighter training for the CF-188s with approximately 23 CF-116Ds and 14 CF-116As. The unit also played an important part in the regular Maple Flag exercises held in Canada, acting as an

aggressor training unit. As a result, its aircraft wore a wide variety of multi-coloured camouflage schemes. Some aircraft even had a false canopy outline painted on their underside. The squadron's moose emblem was carried in red on a blue fin band, and later in black when the fin band was deleted. 419 began to take delivery of AUP CF-116s in June/July 1993 but the 'new' aircraft had a relatively brief career. The February 1995 decision to withdraw the CF-116 from service saw 419 Sqn stand down on 1 April 1995 and disband on 24 June. At that stage, six aircraft (including one non-AUP) were left with the unit, to be flown into storage.

This line-up of AUP CF-116Ds is from 419 Sqn. Note the black-tipped radome and striped pitot tube on the aircraft nearest the camera.



AETE Aerospace Engineering Test Establishment

The AETE, then based at Ottawa, took delivery of its first CF-116 (116801) on 19 December 1968. AETE was tasked with type evaluation and weapons qualification for the CAF and continues to undertake those functions today. The unit moved to Cold Lake AFB, Alberta, during 1971, and flew at the Primrose Lake Evaluation Range, 19 miles (30 km) north of the main base. AETE

flew five CF-116s, including the oldest operational example (116702), and all its aircraft carried the Establishment's red 'X' marking on the fin. In late 1995, a single AUP CF-116 remains active with the AETE (under the aegis of 417 Sqn), chiefly to maintain pilot currency on the type in the event of the need arising to ferry them to a new customer.

the supply of 15 F-5Es and three F-5Fs (plus spares) in a \$55 million deal. The Carter administration imposed arms restrictions on 1 October 1976, but these aircraft escaped, as deliveries commenced in March that year. The FAC's first F-5 unit thus became Grupo 7 of Ala 1, based at Cerro Moreno/Antofagasta, part of 1 Brigada, at BA Los Condones. From their base on the northwestern coast the F-5Es were assigned air defence duties over the northern half of Chile, while the Punto Arenas-based Mirage 50Cs had responsibility for the southern half.

A Grupo 7 F-5E, wears the red fin stripe of an FAC aggressor. Today's Tiger III Plus F-5s wear low-vis grey serials and only the national marking on their rudders disrupts their anonymous appearance.



The US embargo hit the flow of spares, however, and only a handful of F-5s (reportedly four) were still operational by the mid-1980s. When Brazil was looking to boost its F-5 fleet in 1986, Chile offered the FAB its aircraft. Technical assistance was increasingly supplied by Israel, which equipped the surviving F-5s with Shafir AAMs and helped in local modifications to the AIM-9Bs supplied previously by the US. A deal was struck in 1988 with IAI to acquire 12 Kfir fighter-bombers with the intention of disposing of the F-5s, through a third party, in return. This proposal was abandoned with

the increasing ability of local aviation manufacturer ENAER to maintain the F-5s. In the late 1980s, the F-5 became the FAC's aggressor training aircraft and some aircraft began to wear Dayglo stripes. In 1988, as a sign of improving US-Chilean relations, Grupo 7 flew against US Navy aircraft from the USS *Independence*. Co-operation between Chile and Israel was even more tangible, leading to a contract between the FAB and IAI to upgrade all of Grupo 7's 12 F-5Es and two F-5Fs to F-5E Plus Tiger III standard. While not an airframe upgrade, the comprehensive Israeli-

designed avionics upgrade adds an Elta EL/M-2032B multi-mode radar and a revised armament fit of Rafael Shafir or Python III AAMs, if required. The Tiger IIIs have also received an El-Op HUD/HOTAS controls, INS/GPS and video camera system and two Elbit cockpit MFDs (monochrome) coupled with a MIL-STD 1553B databus. The first F-5E and F-5F were upgraded by IAI in Israel but the rest of the work is being undertaken by ENAER. The first F-5E Plus Tiger III was rolled out in Israel in late 1992 and redelivered to the FAB in September 1993. The first ENAER upgrade was

delivered in 1994. An Israeli-supplied reconnaissance pod has also been delivered to the FAB for use by its Tiger IIIs.

In 1995 Honduras began to transfer its F-5s to the FAB, with American approval. The US reportedly was unhappy at such high-performance combat aircraft remaining in the Central American region after the disappearance of the perceived Communist threat in Nicaragua and elsewhere. The ex-FAH F-5Es have entered service with Chile's Grupo 7, to cover the shortage of Chile's own F-5s as they undergo upgrading.

Ethiopia

Ye Ithopya Ayer Hayl (Ethiopian air force)

During the reign of Emperor Haile Selassie I, the United States was a major backer of Ethiopia and supplied much equipment to the armed forces. In July 1960 a squadron of F-86F Sabres was delivered to the air force but these were replaced in 1966 by the F-5. Ten F-5As and two F-5Bs were handed over, followed by three F-5As in 1972. In 1973 the air force contracted to receive a further 14 F-5Es and three F-5Fs. However, on 13 September the following year, Haile Selassie was deposed in a violent Marxist-inspired coup. Power was seized by the Soviet-backed PMAC (Provisional Military Administrative Council). Despite this, the Carter administration authorised the transfer of eight F-5Es in 1975. Ethiopia's northern Red Sea ports, in Eritrea, were still of great Cold War significance to the West. The six remaining F-5Es were embargoed and later delivered to the USAF's 3rd TFW, forming the 26th TFTS aggressor unit at Clark AFB, in the Philippines. Additional F-5As (perhaps two or three) were acquired by Ethiopia from the Imperial Iranian Air Force.

The situation in Ethiopia became increasingly turbulent as the governing powers and civilian opposition waged an undeclared war on each other. The United States gradually withdrew its personnel and

finally cut diplomatic relations with Ethiopia in 1977, after the accession of General Mengistu Haile Mariam. That same year the Soviet Union ceased its active support of Somalia, Ethiopia's long-time opponent in the Ogaden dispute, in favour of Ethiopia. The Somali government supported the claims of the Western Somali Liberation Front, which sought to liberate 'former Somali territory' in Ethiopia's western Ogaden Desert. In May 1977, with the Ethiopian regime distracted by violent domestic troubles, a concerted Somali effort was launched to capture several Ogaden towns. By early August virtually all of the Ogaden was in Somali hands. Both sides began bombing each other's positions and two F-5s were lost to Somali AAA. As the fighting intensified, and swung in Somalia's favour, the Soviet Union declared outright support for Ethiopia and its remaining troops in Somalia were ejected. The Ethiopian air force moved its F-5 and Canberra force to Bhir air base, at Dire Dara, where its aircraft were being flown by

Six of Ethiopia's 14 F-5Es were embargoed by the US after the 1974 coup, and they later found their way into the USAF aggressor fleet.

Israeli pilots. They faced Iraqi and Syrian pilots in Somali air force aircraft, flying from Berbera. Somali ground forces were advancing steadily eastwards towards Dire Dara and were stopped only by stubborn resistance from a trapped Ethiopian division, supported by Cuban MiG-23s and ground forces. A massive airlift of military equipment began from the USSR on 25 November 1977 and this turned the tide against Somalia. With the Cuban presence in Ethiopia escalating, conscription in force in Somalia, Pakistani pilots flying MiGs against Ethiopia, and French and US naval forces standing by off the coast, the USSR used Mi-6 helicopters to airlift 70 Ethiopian

tanks behind the Somali lines. Somali forces were routed, but the Ethiopians did not press their advance into Somalia. The border remained in dispute until a treaty was signed in 1988.

Twelve F-5As, two F-5Bs and eight F-5Es supposedly survived the fighting and were offered for sale in 1984 (though how many of these were flyable airframes is unknown). Two aircraft are also known to have escaped to Sudan seeking political asylum. The surviving F-5s remained active, flying from Debre Zeit, and spares assistance was obtained from Vietnam from its captured stocks. Ethiopia's F-5s were allegedly disposed of to revolutionary Iran in 1986.



Greece

Elliniki Polemiki Aeroporria (Hellenic Military Aviation)

As part of a US-led re-equipment and modernisation attempt, a large force of F-104s and F-5s was supplied to the Greek air force between 1960 and 1965. Courtesy of the US Mutual Assistance Program (MAP), 52 Sidewinder-armed F-5As were delivered from June 1965 instead of the rival G91. They were accompanied by 16 RF-5As and nine F-5Bs. Ten years later additional aircraft – 10 F-5As and two F-5Bs – were acquired from Iranian surplus stocks. Jordan supplied 13 F-5As and six F-5Bs in November 1983, while Norway transferred

nine F-5As in May/August 1986. Yet more F-5s came from Jordan in 1989, in the shape of 16 F-5As and four F-5Bs. A Dutch offer of 11 aircraft was turned down in 1987 but agreed in April 1991, when a further 11 NF-5As and a single NF-5B joined the sprawling Greek F-5 fleet. This has led to a very varied mix of camouflage schemes being worn by Greek F-5s, and in the case of the ex-Jordanian Air Force aircraft their original black, white and green roundels could often be seen through their weathered finish.

At the height of its operational career in the Greek air force, the 28th Tactical Air Command had five squadrons:

111 Pterix

337 Mira – F-5A/B (replaced by F-4Es in 1974),
341 Mira – F-5A/B
343 Mira – F-5A/B

110 Pterix

348 Mira – RF-5A (replaced by former Luftwaffe RF-4Es in 1993),
349 Mira – RF-5A

Many of these aircraft have been withdrawn from use and serve only as a spares source. Five of the 13 extant RF-5As were converted to F-5A standard (with the arrival of additional RF-4s) and virtually none

of the remaining RF-5As still serve in their intended reconnaissance role. For most of its life in Greek hands the F-5 was dedicated to the ground attack role, but today the survivors are tasked with a day fighter role as their primary mission. Most active aircraft have been fitted with Martin-Baker Mk 10LF zero-zero ejection seats, in a programme initiated in 1986, and all the Jordanian aircraft came with this seat installed. However, some aircraft still retain Martin-Baker Mk 7s. Some aircraft now carry AIM-9Ls in place of their earlier AIM-9P Sidewinders.

Today Greece has a holding of over 100 F-5s, more than enough for its three current squadrons, and thus assuring a spares supply for years to come.



Seen at Larissa, this is one of 349 Mira's veteran RF-5As which replaced Greece's even older RF-84Gs, which were retired in 1991. Most RF-5As have had their camera fit removed and this aircraft is carrying its 20-mm cannon.



The ex-Dutch NF-5s are among the best-condition F-5s in the Greek air force. These two NF-5As exhibit three colour schemes between them, as the furthermost aircraft is fitted with grey/green camouflaged tip tanks.

F-5 Operators

Taktiki Aeroporikis Dynamis (Tactical Air Force)

341 'Asos' Mira Anakethisis Imeras (Day Fighter Squadron)

Originally based at Nea Anchialos, this unit was the Greek air force's first F-5 squadron and began to receive its aircraft in June 1965. The F-5 was delivered as an interceptor and remains in that role today.

Honduras

Fuerza Aérea Hondureña

During the 1980s Honduras became the front line of a United States-backed campaign against Marxist Nicaragua. In 1979 the pro-US Nicaraguan President Somoza was toppled in a military coup led by the FSLN. This Marxist-Leninist group became the dominant party in a subsequent coalition government and consolidated its power (declaring a state of emergency in 1982) until Daniel Ortega was elected President in a virtually one-party state. Resistance to the FSLN government, by the so-called 'Contras', was aided and organised by the United States, with much assistance supplied by Honduras. The Reagan administration felt it was undesirable to have a Communist regime at large in its own 'backyard' and so sent a substantial amount of arms and equipment to the Honduran armed forces, to operate (nominally) under its banner. The Honduran air force's main combat force consisted of over 20 Israeli-supplied Dassault Super

343 'Asteri' Mira Anakethisis Imeras

343 Mira obtained its aircraft from the first batch of Greece's MAP-supplied F-5s and

In the late-1980s, Honduras acquired its F-5Es, as a reaction to activities of its Marxist-inspired neighbour, Nicaragua. In 1995 they were all transferred to Chile.

Mystère B.2s, which had been upgraded by the IDF/AF and delivered in 1976, along with the survivors of 14 vintage F-86E/F/Ks obtained from the USA, Venezuela and Yugoslavia. Beginning in 1982, Honduras made repeated requests for 12 F-5E/Fs which went unheeded until 1986. That year, in the face of US unwillingness to supply more potent aircraft, Israel agreed to sell Honduras two squadrons of IAI Kfirs. The US blocked the sale of the J79-powered Kfirs, but decided that Honduras did require an effective interceptor to halt arms flights into Nicaragua. Ten refurbished F-5Es and two F-5Fs were taken from US stocks and delivered between December 1987 and April 1989. The F-5s entered service alongside the Super Mystères as part of the Escuadrilla de Caza, based at BA Coronel Héctor Carracciolo Moncada, La Ceiba/Golosón. With the subsequent

subsequently some ex-Jordanian, Iranian, Norwegian F-5s. 'Asteri' Mira is based at Thessaloniki/Mikra as part of 113 Ptérix.

349 'Kronos' Mira Anakethisis Imeras

Originally based at Thessaloniki, 349 Mira maintains a flight of former-348 Mira RF-5As alongside its standard F-5As,

although these aircraft have had their camera fit mostly removed and are used largely in the fighter role. 349 Mira was originally attached to 111 Ptérix but was transferred to 110 Ptérix in 1989. The flyable examples of the Dutch NF-5As and Bs entered service with 349 Mira in 1986. By 1994, 349 Mira had moved to Larissa, to partner 341 Mira. At that base, the F-5s accompany the RF-4Es of 348 Mira, the one-time RF-5 operator, which is now the air force's prime reconnaissance squadron.



reduction in tension in the region and the normalisation of relations, particularly between Nicaragua and the USA, the Honduran F-5s were transferred to the

Chilean air force in 1995 with US acquiescence. All 10 F-5Es and two F-5Fs were first refurbished by Lockheed at Palmdale, beginning in August 1994.

Indonesia

TNI-AU/Tentara Nasional Indonesia-Angkatan Udara

Between 1965 and 1977 the Indonesian air force had relied on an increasingly deteriorating stock of largely Soviet-supplied aircraft. During the late 1970s attitudes towards the West softened and in 1977 a major restructuring and modernisation plan for the air force called for the acquisition of A-4s and F-5s. In 1978 the US offered eight F-5Es to replace the Australian-supplied CA-27 Sabres still in service with the TNI-AU's sole air defence squadron. The F-5s entered service with 14 Skwadron Udara, at Madiun-Iswahyudi, with deliveries completed by 1980. The first batch comprised eight F-5Es and four F-5Fs, in a package worth \$84.9 million. A follow-on order for four F-5Es, worth \$22.9 million, was placed in August 1978.

In May 1985 the TNI-AU command structure was reformed, and the five former Air Regions were amalgamated into two Operational Commands, KOOPSAU I and II. Headquartered at Jakarta KOOPSAU I is responsible for operations in the eastern

half of the Indonesian archipelago, and thus 14 Skwadron Udara comes under its control.

In December 1989 the TNI-AU began to take delivery of 12 F-16As and four F-16Bs and these are based alongside the F-5s, as are the air force's BAe Hawk T.Mk 53s. In March 1995 Belgium's SABCA was chosen to upgrade eight F-5Es and four F-5Fs, in a \$40 million contract. The three-year contract will require a 20-month test and engineering phase to be completed at SABCA's Gosselies plant, involving an F-5E and F-5F. The remaining 10 aircraft will be upgraded in Indonesia with SABCA-supplied kits. The aircraft will be refitted with a GEC-Marconi Avionics HUD/WAC and Sky Guardian RWR,

Indonesia relied on the F-5 until the arrival of its first F-16s in 1989. Now its surviving Tiger IIs are being comprehensively upgraded to act as lead-in fighter trainers.

new air data computer, stores management system, HOTAS controls and a MIL-STD 1553B databus. Their ESCO APG-69(V)-3 radars will be upgraded to (V)-5 standard. As a result, the F-5s will be far more compatible with the TNI-AU's F-16s and Hawk 100/200s. The two 'prototype' aircraft

(F-5E TS-0501, F-5F TS-0516) were delivered to Gosselies on 31 May 1995, on board an Antonov An-124.

Unit: 14 Skwadron Udara

Base: Maidun-Iswahyudi

Equipment: F-5E/F



Iranian-style camouflage (albeit in NVAF markings) is today on display at the Military Museum in Ho Chi Minh City.

Whatever the case, well over 100 F-5s were available for use when fighting broke out with Iraq in 1980. There is little documentary evidence of IRIAF F-5 activity during the Gulf War of 1980/88, much less

than the F-4 or even F-14, for example. Heavy fighting after the Iraqi invasion in 1981, when many aircraft were lost by both sides, gave way to a war of attrition. Perhaps 50 F-5s were lost, but spares trickled in from Israel – and from the US, as part of the 'Irangate' dealings. When Iran launched its Karbala 5 offensive against

weapons/ballistics computer. Until the Islamic revolution it had been planned to replace the F-5 with the F-16 and F-18L. Indeed, Iran had signed for 160 F-16s when the Shah was deposed in February 1979 and a decidedly isolationist government was installed.

Serviceability levels in the newly established Islamic Republic of Iran Air Force plummeted as American personnel and technical support evaporated. The F-5 was one of the more easily maintainable types in an air force whose inventory included the F-4 and F-14. It is possible that some spares and technical assistance were given by North Vietnam. An F-5E wearing

A line-up of pristine Imperial Iranian Air Force F-5As, in Iran, during 1965. Note the IIAF F-86 in the background and the SUU-20 practice weapons dispenser on the nearest F-5.



Basra in January 1987, both Jordan and Saudi Arabia offered to send F-5s and crews to Iraq. Iraq was aided surreptitiously by many Gulf neighbours, including Kuwait, but it is not believed that F-5s ever fought against Iran. By the end of the fighting perhaps only 20 to 25 F-5s remained active in Iran and the order of battle given below is correct only for the Imperial Iranian AF. The Islamic Republic of Iran AF did attempt to maintain the command structure it inherited, but the present composition of the IRIAF is unknown.

IIAF (to 1979)/IRIAF
TAB 1 — two squadrons
Mehrabad

TAB 2 — one and a half squadrons
Tabriz

TAB 3 — one squadron
Hamadan

TAB 4 — two squadrons
Dezful

An IIAF F-5B at Tehran/Merehbad, in March 1967, where two squadrons were based until at least 1979. A large squadron badge is just visible on the fin of the F-5A in the background. Note also the mix of Arabic and 'Roman' characters.



Jordan

Royal Jordanian Air Force/AI Quwwat al Jawwiya al Malakiya ai Urduniya

Under the moderate leadership of King Hussein, Jordan has maintained a largely pro-Western stance in a generally volatile Arab Middle East. Military assistance has been supplied largely by the United States and Saudi Arabia. During the 1970s US assistance to the RJAF was limited – a small number of supplementary F-104s was delivered in 1976. Requests for A-4 Skyhawks and F-16s were refused, so Jordan turned instead to Saudi Arabia to fund the purchase of Mirage F1CJs. However, in late 1974 20 F-5As and two F-5Bs were obtained from the Imperial Iranian Air Force to replace Jordan's Hawker Hunters. The F-5s were delivered in two batches to Mafrag Air Base, replacing the Hunters of Nos 1 and 6 Sqns. The Hunters were later donated to Oman. An additional delivery of 10 F-5As and two F-5Bs, from the IIAF in March 1974, allowed the formation of No. 2 Sqn, for advanced training, and Northrop later delivered two new-build F-5Fs. No. 1 Sqn now flies the Mirage F1EJ, while No. 2 Sqn flies Bulldogs.

In 1975 the US began to supply more modern, radar-equipped F-5Es and F-5Fs. Ultimately, 61 F-5Es and 12 F-5Fs were handed over plus one F-5F later obtained from Sudan. Two additional squadrons were thus formed, Nos 9 and 17 Sqns, both based at Prince Hassan AB (H-5). These well-armed aircraft were delivered with AIM-9J Sidewinders and Rockeye cluster bombs. No. 17 Sqn acted as the RJAF's F-5 OCU and operated seven F-5Fs.

The Jordanian F-5 fleet then underwent a period of transition. Some aircraft were variously reported as stored or active with a 'part-operational' unit at Al Jafra Air Base. In November 1983, 13 early F-5As and six F-5Bs were transferred to the Greek air force. Four more aircraft were offered for sale in 1989. A third F-5E unit, No. 11 Sqn, was then established at Prince Hassan AB and later moved to Azraq, but it was disbanded and its aircraft reassigned to the other F-5 squadrons.

In 1985 the RJAF signed a deal with the UK's Smiths Industries to upgrade its aircraft systems and integrate the AGM-65D, 60 of which had been ordered in 1983. Smiths added a new HUD/WAC and radar altimeter along with a BAE LINS 3000 laser INS as part of its own Hunter nav/attack suite. Seven F-5Es aircraft were sold to Singapore, in 1994, to pay for the fleet upgrade. The RJAF also attempted to acquire Selenia ALQ-234 ECM pods. The F-5 upgrade commenced in 1989 and also added chaff and flare dispensers. As a result of its involvement in the recent Middle East peace accord, Jordan now expects to obtain 24 ex-USAF F-16A/Bs to modernise its air force in the near future.

No. 9 Sqn

Variously reported as based at Prince Hassan AB and Al Jafra it has been suggested that No. 9 Sqn is in fact the only true operational F-5 unit at H-5 (and perhaps in the RJAF), as the other two residents (Nos 6 and 17) have been disbanded.



Right: This grey RJAF F-5E is carrying an SUU-20 practice bomblet dispenser and also has an elaborate false canopy painted on its underside.

Below: Also toting an SUU-20 is this F-5E from No. 9 Squadron. This unit is believed to be the RJAF's last.

No. 17 Sqn

No. 17 Squadron shared Prince Hassan AB (H-5) with Nos 6 and 9, and all three squadrons were, at one time, tasked with the air defence of northern Jordan. Its operational status is now uncertain (see entry for No. 9 Sqn).



No. 19 Squadron

This unit was based at King Faisal Bin Abdul Aziz AB, also known as Al Jafra. Built with Saudi assistance between 1974 and 1976, it is a large facility (over 50 km²/19 sq miles) designed to accommodate and support far more aircraft than are based there by the Jordanian air force. It became operational in 1980. The operational status of No. 19 Sqn is now uncertain. It is believed that the RJAF's operational F-5 force has contracted to a single squadron, which may be No. 9 Sqn, based at Prince Hassan AB (H-5).

Armament School

Based at Mowafaq Al-Salti, Azraq, the Armaments School maintains a single F-5E and F-5F alongside the based Mirage F1s.

Left: A No. 17 Sqn F-5E is seen on the ramp at Al Jafra Air Base, otherwise known as King Faisal Bin Abdul Aziz AB. The Jordanian F-5 fleet has been in a constant state of flux for many years and is steadily contracting. Jordan may soon begin to take delivery of up to 72 F-16s, and Al Jafra is likely to be their first operational home – leaving the F-5s at Prince Hassan AB.

No. 6 Squadron

Previously based at Mowafaq Al-Salti, No. 6 Sqn has now moved to Prince Hassan AB, alongside No. 17 Sqn. Prince Hassan AB (H-5) is one of two 'H' airfields, so-called because they are situated alongside a major oil pipeline which terminates at Haifa. No. 6 Sqn is commanded by one of King Hussein's sons and has been formally linked with the RAF's No. 6 Sqn. Its operational status is now uncertain (see entry for No. 9 Sqn).



F-5 Operators

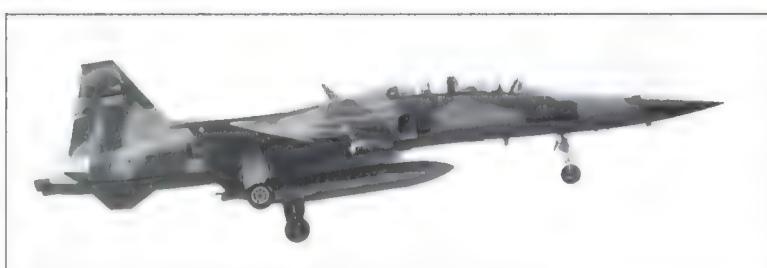
Kenya

Kenya Air Force

Kenya has long maintained a pro-Western stance and has received substantial support from the United States in return for harbour facilities at Mombasa and air transit rights. Until the arrival of the F-5 the air force had relied on an ageing force of British-supplied Strikemasters and Hunters, stationed at Nanyuki, its main base of operations. The US had first offered a number of surplus Iranian F-5A/Bs in 1976, but this was deemed unnecessary by the Kenyan authorities. The escalating war in the Ogaden and tension in neighbouring Uganda changed that view, and led to the acceptance of 10 F-5Es and two F-5Fs (worth \$75 million), along with AIM-9s and AGM-65s. Deliveries began to a newly formed unit at Nanyuki, in late 1978. The last Hunters were withdrawn in 1979. Two F-5Fs were delivered as attrition replacements in July 1982.

Immediately after this delivery, on 1 August 1982, a group of junior air force

Right: The supersonic F-5 was a definite step up from the Hawker Hunters previously operated by the Kenyan Air Force. Deliveries began in 1978.



officers staged an unsuccessful coup. As a result, the air force was disbanded on 22 August and later reformed as the '82 Air Force. In 1994 the air force readopted its former title. The F-5s remain its front-line type, along with a training/light attack squadron of British Aerospace Hawk Mk 52s delivered between 1980 and 1982.

This is one of the two F-5Fs delivered to the Kenyan Air Force as attrition replacements in June 1982. Two F-5Fs were already in service.

Korea (South)

Hankook Kong Goon/Republic of Korea Air Force

Korea acquired its first F-5s in April 1965, taking delivery of 16 F-5As and four F-5Bs. This initial batch was delivered to the 105th Fighter Squadron, 10th Wing, based at Suwon AFB. There they replaced F-86Fs. Subsequently, 14 additional F-5As were delivered to the 102nd Fighter Squadron, with the same wing. The 105th declared itself operational by September 1965. By 1971, 87 F-5As, eight RF-5As and 35 F-5Bs had been delivered to the RoKAF. Korean F-5As were delivered in the USAF's standard Vietnam camouflage of two-tone green and brown with grey undersides, but the F-5Bs retained their natural metal finish, with large national and unit markings. At one point the F-5 equipped the Suwon-based 'Black Eagles' aerobatic team. These brightly painted aircraft wore an extravagant red, white and blue scheme, over a natural metal finish, with orange detailing.

In 1972, with the situation growing desperate for government forces in Vietnam, Korea transferred 36 F-5As and all its RF-5As to the Vietnamese Air Force. The United States made good these 'losses' by replacing them with F-4s and more modern F-5Es. After the fall of Vietnam, 19 former Vietnamese F-5As (which had escaped) and two ex-USAF F-5As were handed over to the RoKAF. The Air Force had intended to acquire the RF-4E for reconnaissance tasks, but this plan was shelved and, instead, several F-5As were converted with camera noses. These RF-5As, the last of Korea's

early-model F-5s, were withdrawn from use in 1990 following the arrival of a second batch of RF-4Cs.

The F-5 entered Korean service in 1974, when 19 ex-VNAF aircraft were delivered (along with a similar number of F-5As, as mentioned above). This laid the foundation for a run-on acquisition of 126 new-build F-5Es and 20 F-5Fs, and the F-5 became far and away the most numerically important type in the RoKAF. The first F-5Es were allocated to the 1st Fighter Wing, based at

Kwangju, although as late as 1986 there were still F-86Fs flying alongside the Tiger IIs. Korea, which was seen as an important ally by the United States, was nonetheless frustrated in its attempts to acquire more potent combat aircraft. When Taiwan was denied the BVR-capable F-5G (F-20 Tigershark), Korea made a move to obtain licence-production rights. The F-5G would have been an interim type in advance of the RoKAF's planned acquisition of the F/A-18 (which was finally selected in the 1989 'FX' competition and then replaced by the F-16). Korea failed to win the F-5G for itself and instead returned its attention to the F-5E.

In 1980 South Korea signed an initial licence-production deal worth \$104 million,



for 68 F-5s plus engines. During the late 1970s and early 1980s the country had implemented an extensive programme of armament self-sufficiency and laid the foundations for an indigenous aviation industry that today is contemplating building a range of civil aircraft, helicopters and high-performance military trainers. The F-5 was one of the earliest links in this chain.

In 1976 Korean Air Lines, the national flag carrier, established an Aerospace Division in Seoul. It began undertaking depot-level maintenance of RoKAF aircraft and, later, USAF aircraft stationed in Korea, before turning its attention to the F-5 project. Korea contracted to acquire 48 F-5Es and 20 F-5Fs, and all of these were assembled by Korean Air. The General Electric J85 powerplants were also assembled in Korea, by Samsung (today Samsung Aerospace Industries). In Korean service the F-5 is known as the Chegong-ho (Skymaster) and work on the first aircraft began in 1981. The first Korean-built F-5 (an F-5F) made its maiden flight in September 1982. By 1986 all had been delivered. In November 1995 Samsung Aerospace Industries handed over the first of 108 F-16Cs and F-16Ds it intends to co-produce for the RoKAF. Deliveries began as far back as 1986 and Korea will ultimately have a fleet of 160 F-16s, but for the time being the F-5E remains its most important combat type. Northrop Grumman and Samsung have joined forces to rework 27 F-5Bs, with an eye on the other 200+ aircraft in the fleet. IAI is also in the bidding for any upgrade contract.

1st Fighter Wing

Base: Kwang Ju

Component Squadrons:

115th Tactical Fighter Squadron

122nd Tactical Fighter Squadron

123rd Tactical Fighter Squadron

Operational Conversion Unit (F-5E/F)



5th Fighter Wing

Component squadrons:

201st Tactical Fighter Squadron

203rd Tactical Fighter Squadron

10th Fighter Wing

Base: Suwon

Component Squadrons:

102nd Tactical Fighter Squadron

103rd Tactical Fighter Squadron

111th Tactical Fighter Squadron

Left: ROKAF F-5s carry little in the way of squadron badges or other markings (except for a black tiger's head, on occasion). Even today, service aircraft remain essentially unchanged from this pre-delivery picture of a gaggle of F-5Es.

Libya

Al Quwwat Alijawwiya Al Libiyya/Royal Libyan Air Force

The Royal Libyan Air Force placed an order for a mix of 18 F-5As and F-5Bs in 1968. Eight single-seaters and two two-seaters had been delivered when King Idris (who had ruled since independence from British and French administration in 1951) was deposed in a military coup. While the ailing King was in Turkey, the Revolutionary Command Council took charge on 1 September 1969 and proclaimed a new Libyan Arab Republic. Libya's F-5s, along with the bulk of its mainly US-supplied air force, were based at Wheelus AFB, a massive installation near Tripoli that had provided vital training space for USAFE crews since the mid-1950s. The RAF also had a similar leased air field at El Adem, but it was smaller field, used mainly as a staging post. The USAF leased Wheelus, under a contract which was not then due to expire until 31 December 1972, but after the coup the 57 aircraft which happened to be in the country were immediately withdrawn. In the event, the US quit Wheelus by 30 June, following the British who had departed in March.

Libya insisted that the US continue to deliver the 10 outstanding F-5s ordered before the coup. However, the Libyan aircraft became embroiled in Dassault's controversial deal to supply Mirages to the new regime, Libya's hard-line policy in support of Egypt against Israel, and the United States's own support of Israel. The remaining F-5s were never handed over, but those that were continued in service with

the assistance of Greek personnel. As US relations with Colonel Khadafi (who had emerged as leader of the RCC and *de facto* head of state) deteriorated and spares became impossible to find, the Libyan aircraft were disposed of, it is believed, to Pakistan and Turkey.

Libya was a little-known (and short-lived) F-5 operator. Its F-5s were based at Wheelus Field, the extensive USAF facility near Tripoli.



Malaysia

Tentara Udara Diraja Malaysia/Royal Malaysian Air Force

Malaysia became an F-5 customer in 1982 when it ordered a package of 14 aircraft, worth \$39 million. Three attrition replacements were later acquired and these joined the others at Butterworth (6 AB).

Training requirements were undertaken by a pair of F-5Bs, but these were disposed of to Thailand when the RMAF acquired four two-seat F-5Fs. Malaysia was the launch customer for Northrop's RF-5E Tigereye reconnaissance aircraft. Two RF-5Es were acquired in 1983. Until 1988 Malaysia depended largely on the Royal Australian Air Force for its air defence. As part of a five-power agreement between Australia, New Zealand, the UK, Malaysia and Singapore, the RAAF stationed a force of Mirage IIIs at Butterworth. These were withdrawn in 1988, and have been replaced by F/A-18s on TDY. The F-5 was therefore Malaysia's first line of defence into the 1990s. RMAF aircraft are armed with AIM-9s and have a PGM capability for their secondary ground attack role. Malaysia has given the air force designation M29 to all its F-5 models.

Butterworth is the headquarters of the

Malaysia has its own niche in the overall F-5 story as it was the first customer for the RF-5E Tigereye reconnaissance variant. It is thought that No. 11 Sqn may transfer its identity to one of the new MiG-29N squadrons.

five-power Integrated Air Defence System (IADS) to which F-5Es from the RMAF's No. 12 Sqn have been allocated, along with F-5s from Singapore. All IADS air assets are integrated with a SAM and air defence radar network throughout Malaysia and Singapore. Having said that, RMAF RF-5Es are forbidden to overfly Singapore, in case they have their cameras rolling.

Malaysia considered acquiring a follow-on batch of F-5s to form a second air defence squadron, but later turned its attention to more advanced combat aircraft including the Tornado ADV and F-16. After a hard-fought competition Malaysia ordered a mix of MiG-29Ns (for air defence) and F/A-18Ds (strike/attack) to replace the F-5 and A-4.



MiG-29N (MiG-29SD) deliveries have begun and two new squadrons – No. 17 (OCU) and No. 19 – have been formed at Kuantan. As a result, the days of Malaysia's Tiger IIs are now limited. However, the RMAF has expressed an interest in upgrading its aircraft with FIAR Grifo F/X Plus multi-mode radars. Some reports indicate that No. 11 Squadron may have disbanded during 1994, as aircraft wearing its squadron badge are no longer in evidence at Butterworth.

No. 1 Air Region (HQ Kuala Lumpur)

Unit: No. 11 'Cobra' Squadron

Base: No. 6 Air Base, Butterworth

Equipment: F-5E/RF-5E

Unit: No. 12 'Lightning' Squadron

Base: No. 6 Air Base, Butterworth

Equipment: F-5E

Mexico

Fuerza Aérea Mexicana

Mexico's air force is geared largely towards self-defence and COIN duties. Previously this posture, like all Mexico's defence policy, was motivated by its secure relations with the United States to the north, but an unpredictable political and military situation among its southern neighbours. In recent times its internal security has been threatened by the popular Zapatista revolutionaries, coupled with a worsening economic situation. Against this background Mexico's F-5s are something of an anomaly. Between August and November 1984, 10 F-5Es and two F-5Fs were delivered to the FAM. The purchase, worth \$110 million at the time, was funded by Mexico's oil wealth, which was then considerable. The United States also provided extensive personnel training and set up an air defence radar system.

The Sidewinder-armed F-5s operate as part of No. 7 Group, the only one of the FAB's nine groups to operate combat jets.

No. 7 Group's second squadron (Escuadrón Aéreo de Pelea/Air Combat Squadron 202) operates the AT-33, which entered service in Mexico in 1961.

1º Ala de Combate (1st Combat Wing)

Unit: 401st Escuadrón Aéreo de Defensa (EAD) 401

Base: BAM No. 1, Santa Lucia

Equipment: F-5E/F



Above: Mexico's F-5s are based at St Lucia alongside much of the FAM's heavy transport assets. Until recently this included a sizeable number of C-54s.

Left: The F-5E is the FAM's most sophisticated aircraft but, in the fighting against the Zapatista guerrillas, it was the air force's PC-7s that proved most useful.

F-5 Operators

Morocco

Al Quwwat al Jawwiya al Malakiya/Royal Air Force of Morocco

The Royal Moroccan air force was formed in 1956, when the Kingdom of Morocco regained its political independence from France. Support from the US and France was withdrawn in 1961, when the USSR supplied a squadron of MiG-17s and MiG-15UTIs. US assistance recommenced in 1966, but subsequently Morocco found itself embroiled in internal power struggles and a guerrilla war in the Spanish Sahara.

The United States supplied 18 F-5As to replace Morocco's MiGs, and these aircraft became the air force's prime combat aircraft until the arrival of Mirage F1Cs in the late 1970s. The F-5As were delivered, with two RF-5As and four F-5Bs, in 1966 and were based at Kenitra. Iran later supplied six additional F-5As. In 1977 Morocco was offered 24 F-5E/Fs, but the price (\$120 million) was too much, and the air force opted for the Mirage F1 instead.

By then the Moroccan F-5s had already seen action, although not in the way intended. On 16 August 1972 three F-5As attacked a Boeing 727 carrying King Hassan II back from France. The King survived a single-engined emergency landing by the badly damaged 727 at Rabat. The airport was then promptly strafed by one of the F-5s and later that day four F-5s attacked the Royal palace. King Hassan had declared a royal dictatorship in 1965 and the air

attacks were part of an abortive coup led by officers in the army.

In 1974 Spain began to withdraw from its colony in the neighbouring Spanish Sahara, which bordered Morocco to the south. Morocco and Mauretania agreed to partition the new territory, but the Algerian-backed Popular Front for the Liberation of Saguia el-Hamra and Rio de Oro (Polisario) opposed this. Fighting broke out in spring 1976 and

Morocco received substantial support from the French, including deployments of combat aircraft. The Moroccan F-5 force was based at Kenitra and bore the brunt of air operations (along with a ground attack squadron of Magisters). Morocco agreed a ceasefire with the Polisario in 1978, but fighting with Morocco intensified and several F-5s were shot down by SA-7s (as was a French Jaguar). Operation Uhud, in



Netherlands

Koninklijke Luchtmacht/Royal Netherlands Air Force

In 1966 the Dutch air force selected the F-5 as the replacement for its F-84F Thunderstreaks and T-33s. Potential candidates included the A-4, A-7 and the Mirage 5. The Netherlands had originally hoped to co-produce over 200 F-5s under licence with Belgium; however, Belgium opted for the Mirage 5 as its F-84 replacement. Neither was the F-5 the Dutch air force's favoured option, and several improvements to the basic design were called for, which were similar to those implemented by Canada for its CF-5. As a result, the Netherlands opted to acquire its F-5s from the Canadair production line. On 1 February 1967 the Dutch government finally announced its intention to acquire 105 F-5s, under the Canadair model designation CL-226 and the Dutch air force designation NF-5A/NF-5B.

The Netherlands had hoped to acquire enough aircraft to equip four fighter squadrons (with 18 NF-5As and three NF-5Bs each) plus a fifth reconnaissance squadron, with 18 RF-5As and three NF-5Bs (for No. 306 Sqn). This required a total of 90 single-seat and 15 two-seat aircraft. Instead, this order was revised to exclude the RF-5 version and include 75 NF-5As and 30 NF-5Bs.

To attract the Dutch order in the first place, the Canadian government offered a substantial offset programme which amounted to C\$27.7 million of the C\$138.8 million order. Co-production agreements were established with Fokker subsidiaries Avio-Diepen and AvioLanda. These firms not only completed sub-assemblies for the NF-5 programme but for Canada's CF-5s also. However, Canadair undertook final assembly and flight testing for all CF-5s and NF-5s.

The Dutch instigated several additional changes to those made by Canadair. Many of the avionics systems fitted to the CF-5 (such as the UHF D/F, Sperry navigation system, ISIS sight and camera system) were deleted. The NF-5 carried the standard non-computing F-5 weapons sight, Canadian Marconi 668 Doppler and 703 navigation equipment with roller map display and Bendix heading and reference system. In addition, the NF-5 gained a manoeuvring flap system for use at high speed. This allowed the leading-edge flaps to be rapidly deployed in combat, via a switch on the right throttle grip. The flaps were also connected to the tailplanes and speed brakes to dampen any pitching motion. The flap modification required the

main wing spar to be strengthened.

The 17th F-5 off the Cartiereville production line was the first NF-5 (NF-5A, K-3001) and it was rolled out on 5 March 1969. This aircraft made its maiden flight on 24 March, with Bill Longhurst at the controls. The first NF-5B (K-4001) flew on 7 July 1969. The first two NF-5As and NF-5Bs were flown to Edwards AFB for test flying with Northrop, as were the early CF-5s. The first NF-5 (NF-5B, K-4002) was handed over, at Canadair's plant 2, on 7 October 1969. This was followed by a larger ceremony, with several aircraft, the following day. The last NF-5 (NF-5A K-3075), the 220th built by Canadair, was delivered to the Dutch air force on 10 March 1972.

NF-5 Production

Model: NF-5A

Canadair designation: CL-226-1A10

Construction numbers: 3001/3075

Serials: K-3001/K-3075

Quantity: 75

Model: NF-5B

Canadair designation: CL-226-1A11

Construction numbers: 4001/4030

Serials: K-4001/K-4030

Quantity: 30

Dutch F-5s were delivered by Dutch pilots in a series of transatlantic flights known as the 'Hi-Flites'. Each aircraft underwent two to four shakedown flights before joining a four/six-ship group for the crossing. The NF-5s staged in pairs, with 30-minute separation, from Bagotville to Goose Bay to Sondrestrom to Keflavik to Lossiemouth to Twenthe – a distance of 5050 km (3,138 miles). The NF-5s were shepherded by USAF C-130s (from the 2nd Aircraft Delivery Group) with UHF and D/F gear, which held station at various points across the ocean, carrying paramedics and life rafts. The first four NF-5s (all NF-5Bs, callsign CORONET EAST) departed on 7 November 1969, arriving at Twenthe on 19 November. The last aircraft arrived in Holland on 20 March 1972.

The Dutch aircraft were delivered in grey/green tactical camouflage. They were regularly repainted to combat the corrosion difficulties that afflicted all F-5s. Large aircraft codes were worn on the nose and repeated on the tail, where colourful squadron badges were also carried. As the F-16 was introduced (steadily replacing the NF-5 into the bargain), a variety of similar grey camouflages was adopted for the NF-5.

fleet. The final variant was an overall light grey scheme, with a small serial displayed on the tail only. Aircraft were repainted after depot level maintenance, but as (towards the end of their careers) many NF-5s did not undergo this, up to four differing camouflage schemes could be found on aircraft by the early 1980s.

To maintain their operational credibility the NF-5 fleet was progressively upgraded throughout its life. The canopies were improved and new avionics added, including an RWR. ALE-40 chaff and flare dispensers were mounted on the rear fuselage and the wingtip tanks were replaced with Sidewinder rails on some NF-5As.

The Netherlands was one of the four European partners in the F-16 'sale of the century'. As its aircraft would be tasked

with a ground-attack mission (as part of 2 ATAF), they would immediately begin to replace the F-5. The first Dutch-assembled F-16 flew in 1979 and a total of 213 was acquired. It was decided that the NF-5 replacement would be spread out between 1985 and 1992. In fact, the last NF-5 unit transitioned to the F-16 in 1991. Over its 21 years of service 21 aircraft had been lost. After their withdrawal, the surviving NF-5s were stored at Gilze-Rijen and then Woensdrecht. Several other NATO nations were interested in acquiring the well-maintained Dutch aircraft. Between 1989 and 1991, NF-5s were disposed of to Greece (11), Turkey (60, although not all airworthy) and Venezuela (seven). The remainder were transferred to museums and technical schools.



No. 315 Squadron and Omschloingsvlucht (Conversion Flight)

The first NF-5s were delivered to No. 315 Sqn and its associated conversion flight in December 1969. No. 315 formed as a Thunderjet squadron in June 1952, later switching to Thunderstreaks in 1956. Its motto was 'Nec timide, nec tumide' (without fear, without recklessness) and the squadron badge comprised a yellow lion's head on a blue disc. No. 315 Sqn became a training unit in 1961, operating as a joint OCU for Dutch and Belgian F-84F pilots. No. 315 departed Eindhoven to take up residency at Twenthe on 1 May 1970, when it withdrew the last of its Thunderstreaks in favour of the NF-5. Until No. 313 took over the task, No. 315 was the designated NF-5 conversion unit and flew 30 NF-5As and 15 NF-5Bs. Some of these aircraft were detached to Gilze-Rijen.

Wearing the yellow lion badge of No. 315 Sqn, an NF-5B departs Twenthe for another training sortie in 1985. Note the old-style camouflage on the fuel tank.

As No. 313 became active with the type, No. 315's complement was reduced. With the establishment of No. 313 as a full-time training unit, No. 315 became a dedicated tactical unit once more and flew its last conversion sortie on 26 October 1972. As it had been the first NF-5 squadron to convert, so too was No. 315 the first squadron to give up the F-5, in favour of the F-16. Conversion to the Fighting Falcon began in March 1986, when No. 315 took over the ACE Mobile Force commitment from No. 314 Sqn.

No. 314 Squadron

The second Royal Dutch Air Force NF-5 squadron was No. 314 which activated with its new type in November 1970. Like No. 315 before it, No. 314 Sqn was established as an F-84G Thunderjet squadron (in 1952) before transitioning on to the F-84F in 1955. Its unit motto was 'Per sapientiam efficiens et immortalis' (efficient and immortal through knowledge) and the squadron badge showed a golden centaur armed with a bow on a red disc. In June 1970 No. 314 accepted its first NF-5A. Based at Eindhoven, it temporarily moved to Gilze-Rijen (during 1971) where part of its establishment was split off to form No. 316 Sqn. In time both units returned to Eindhoven. By May 1972 No. 314 was fully operational. Known as the 'Redskins',

No. 314 was committed to the NATO ACE Mobile Force (North) and made regular deployments to Denmark and Norway. For many years an NF-5 squadron allocated an aircraft as a solo air display ship, but in 1988 (for the air force 75th anniversary) No. 314 Sqn formed the 'Double Dutch' NF-5 pair, which was prematurely disbanded after the 'Frecce Tricolori' crash at Ramstein AFB. Also in 1988 (in September) No. 314 moved to Gilze-Rijen. The 'Redskins' made the change from NF-5 to F-16 in April 1990, the last KLu squadron to do so.

Below: No. 314 Sqn established the 'Double Dutch' aerobatic display team, in 1988. The aircraft nearest the camera is fitted with smoke generators, in the shape of AIM-9s.



No. 316 Squadron

No. 316 was formed at Eindhoven, the last squadron of the Eindhoven 'wing', in 1953. It too was a Thunderjet/Thunderstreak operator before the NF-5 entered service. However, it was disestablished in January 1958 when its F-84Fs were transferred to other units to cover high operational losses. The 'new' No. 316 was formed from an element of No. 314, which moved to Gilze-Rijen for this transition in May 1971. The new No. 316 Squadron stood up on 1 June 1971. Its squadron motto was 'Doelbewust en trefzeker' (purposeful and on-target) and its badge consisted of a hawk on a yellow disc. No. 316 returned to Eindhoven briefly, before setting up permanently at Gilze-Rijen on 27 April 1972, becoming

Seen at Eindhoven, this NF-5B is a No. 316 Sqn aircraft that has been fitted with ALE-40 chaff/flare dispensers. This fin stripe comprises five foxes' heads.

operational the following year. In 1986, with the F-16 entering KLu service, No. 316 Sqn took over the NF-5 TOCC role from No. 313. It now used the NF-5 to act as a lead-in trainer for the F-16. As No. 316 became the sole NF-5 squadron in Dutch service its days became numbered, for reasons of cost and compatibility. On 15 March 1991 a flypast of three NF-5s (12 had been planned but bad weather precluded this) marked the end of 21 years of NF-5 service, which had encompassed 300,000 flying hours.

No. 313 Squadron

The last Dutch F-5 unit to be established was No. 313, which was reactivated at Twenthe in September 1972. No. 313 was formed as a training unit at Volkel on 1 December 1953, before moving to Woensdrecht in 1958. Various name changes afflicted the unit (all related to its varying training duties) before the squadron was once more renamed as No. 313. In October 1968 (as the TVO – Transitie Vliegopleiding) the unit moved to Twenthe. Once there it was renamed as No. 313 Sqn, in 1972. In September that year it exchanged the last of its T-33s for NF-5s. No. 313 Squadron became the NF-5 OCU undertaking the TOCC (Transition and Operation Conversion Course), and replacing the Twenthe-based Omscholingssvucht. No. 313 Sqn began to transition to the F-16 in 1987.



This No. 313 Sqn NF-5A, seen at Twenthe, is in the final configuration for Dutch air force NF-5s with its overall grey scheme and Sidewinder launch rails.

Testgroep KLu

The Dutch air force test and development unit was formed at Twenthe in 1971 specifically as an NF-5 trials unit and was allocated a single aircraft, K-3001. After spending a year at Edwards AFB, K-3001 was delivered to Holland on 29 July 1971 to conduct weapons carriage, instrument calibration and fatigue testing. Its guns were removed and replaced with test instrumentation. Most of the NF-5 upgrades adopted by the KLu were first trialled with the Testgroep KLu.

Norway

Kongelige Norske Luftforsvaret/Royal Norwegian AF

In 1963 Norway began to introduce the F-104G, the standard NATO fighter of the day. A single squadron of Starfighters (Skv 331) replaced F-86Fs in the air defence role, but the KNL soon decided that the costly and sophisticated Starfighter could be substituted by a less 'heavyweight' aircraft, particularly for light strike duties. The Saab 105XT was among the competitors for this order. However, the F-5 was selected as the type which came closest to the air force requirement and, on 28 February 1964, 64 aircraft were ordered (including 35 MAP-funded aircraft). During the course of these deliveries additional F-5s were ordered including, in 1968, 16 reconnaissance aircraft. This permitted the establishment of six F-5 squadrons, each with the statutory strength of 16 aircraft. Several of these squadrons were former wartime squadrons formed as part of the Royal Air Force. As a result, the codes that Norwegian F-5s wore, during their early days, were the same as worn by the World War II predecessors. For example 332 Skv wore the 'AH' series codes, as allocated to No. 332 Sqn.

Assistance in transition and training was provided by the Royal Netherlands Air Force. Norway experiences both extreme Arctic conditions and more humid climates, influenced by the Gulf Stream. To combat these temperature variations Norwegian F-5s were equipped with special anti-icing systems and hot-air blowers for

windshields. Norwegian F-5s were also unique in being armed with Bullpup ASMs and each aircraft was JATO-capable. At one time the KNL referred to its aircraft as F-5Gs and RF-5Gs.

Norway ultimately received a total of 78 F-5As, 16 RF-5As and 14 F-5Bs. (Some sources state that these were Canadian-built aircraft to NF-5 standard, but this is not the case.) Early attrition was high and the squadron organisation suffered accordingly over the years. In 1972 the force was reconstituted into just two squadrons – 336 and 338 Skv, although this situation soon changed. Between 1984 and 1986 surviving F-5s underwent a corrosion prevention programme at the hands of Fokker, followed by a SLEP, instigated by the KNL at its Kjeller depot. The F-5A/Bs received Litton LIS 6000D AHRS, a nose-mounted ALR-46 RWR (different in F-5A) and ALE-38 (later ALE-40) chaff/flare dispensers, along with cockpit avionics improvements.

As had happened in the Netherlands, the end for Norwegian F-5s came largely with the arrival of the F-16 – 78 of which were acquired from the Fokker assembly line. F-5s that were made surplus as a result were transferred to Turkey and Greece. However, Norway remains an F-5 operator, courtesy of 336 Skv, which flies its aircraft as F-16 lead-in trainers. Beginning in 1991 the air force instigated an F-5 upgrade programme, awarding a contract to New York-based

Sierra Technologies Inc. Canada's Bristol Aerospace also undertook a limited structural upgrade, including new dorsal longerons and rewiring. The avionics upgrade replaced the analog systems of the F-5 with digital avionics including a GEC Avionics HUD/WAC, Litton AN-93 laser ring INS, GPS, GEC air data computer and a colour video data system. All these systems are linked through a MIL-STD-1553B databus which allows the easy addition of RWR, ECM, chaff/flare (AN/ALE-40 dispensers are carried), laser designator or FLIR, if required. The new HUD and HUD

symbology is similar to those of the F-16's. The Norwegian upgrade became known as TIGER-PAWS (Program for Avionics and Weapon Systems), despite the fact that its aircraft were early model F-5s (Freedom Fighters) and not actually true Tigers. The first aircraft began conversion in 1993 and the programme was completed by July 1994.

A line-up of 711 Skvadron RF-5As seen Rygge. Note the large unit codes and the original form of serial presentation on the fin.



F-5 Operators



336 Skvadron ('PX')

This was the first KNL unit to transition to the F-5A, and it replaced its F-86Fs in 1965. 336 Skv was based at Rygge and allocated to Air Command South Norway. Following the disbandment of the F-5 OCU (718 Skv), 336 Skv took over the training role using its F-5s as lead-in trainers for the F-16 force. 336 Skv is now the sole remaining Norwegian F-5 operator and flies 15 Tiger-PAWS aircraft (seven F-5As and eight F-5Bs). The first of these was supposed to have been handed over by May 1992, but an expanding test programme at Edwards AFB (and the use of two of the first three aircraft for weapons trials at Eglin AFB) delayed this until December. The contract was completed after 42 months in July 1994.



718 Skvadron ('DP')

At the same time as 336 Skv transitioned to the F-5A, 718 Skv took delivery of the first F-5Bs to act as the type OCU. 718 Skv was based at Sola, one of only three suitable airfields that existed in pre-war Norway. During the 1950s NATO money paid for a rapid expansion of airfield facilities around the country. The squadron's F-5s all wore a red and yellow checker band across the fin. 718 Skv remained at Sola until it was disbanded in January 1983.

332 Skvadron ('AH')

The second F-5 combat unit was Rygge-based 332 Skv. The F-5 replaced this

squadron's F-86Fs in late 1966. This unit was allocated to Air Command South Norway. 332 Skv had originally been formed as a Spitfire squadron with the RAF in 1942. It was transferred to the KNL in September 1945. Its F-5s wore the unit insignia of a battle axe on their fins. 332 Skv was disbanded in 1973, but reformed as the KNL F-16 OCU in mid-1982.

338 Skvadron ('MU')

The last Norwegian North American F-86F Sabre unit, Orlandet-based 338 Skv transitioned to the F-5A in 1967. Its unit insignia was a lightning flash. It survived to become the penultimate KNL F-5 unit, giving up its Freedom Fighters for Fighting Falcons on 30 July 1986.



Pakistan

Pakistan never took delivery of any F-5s through official channels, but there is evidence to suggest that the type has been flown by its pilots for clandestine evaluation. At one time the air force had planned to acquire substantial numbers of F-5As (in 1964 to 1966) and then augment them with F-5Es (in 1970 to 1972). Instead, Pakistan

opted to acquire more affordable French and Chinese equipment (China supplied 74 F-6s for free) along with second-hand F-86s. In 1970, the US again offered the F-5A as part of a virtual 'no-cost' deal, including other aircraft and army vehicles, but Pakistan declined.

During the 1971 war with India, however, it seems certain that F-5s were operating in Pakistan. Saudi Arabia supplied F-86s and F-5 expertise, if not airframes. Libya

dispatched a 'training unit' of F-5s which operated from Sargodha until 1976. Had the war continued, perhaps these aircraft were intended to pave the way for a large-scale transfer of aircraft from Saudi Arabia and Jordan. Jordan had already supplied Pakistan with F-104s (from No. 9 Sqn). They saw action against the Indian air force and two were shot down. There is also evidence that the air force acquired former Imperial Iranian Air Force F-5As, in the early 1970s,

before passing them on to Greece.

After the Soviet invasion of Afghanistan, the United States offered Pakistan a military assistance package that included the F-5. This was rejected out of hand, and in 1981 Pakistan was eventually allowed to acquire F-16s and comparable weapons. The air force's negative reaction to the type may have stemmed from its earlier experiences, which would have reinforced the belief that the F-5 was, by then, outclassed.

Philippines

Hukbong Himpapawid ng Pilipinas/Philippine Air Force

The Philippines Air Force still relies on a dwindling number of F-5s, but is now seeking F-16s as their long overdue replacements.

customer to whom it could pass. With the funds thereby acquired they hoped to obtain 24 F-5Es and two F-5Fs from Korea. No buyer was found (or perhaps any likely customer balked at the condition of the Crusaders). In more recent times the Philippines has examined several options for replacing its F-5s, including ex-Belgian Mirage 5s and ex-Israeli Kfirs (with US funding assistance).

For the time being the F-5s remain in service with the 5th Fighter Wing alongside the S.211s of the 105th Combat Crew Training Squadron. The F-5s were previously based at Basa, but moved after the eruption of Mount Pinatubo in June 1991. In February 1995 the entire fleet of available F-5As was involved in surveillance flights of the disputed Spratly Islands, after Chinese 'fisherman' landed on Mischief



Reef and set up a 'naval base'. The Spratlys are variously claimed by China, Indonesia, Malaysia, the Philippines and Vietnam.

Three F-5A/Bs were to be acquired from South Korea in August 1995 after both nations signed a defence MoU in 1994, but transfer plans were suspended in February 1995 after the Philippines established diplomatic relations with North Korea. Under a five-year, \$580 million

re-equipment programme, 18 new combat aircraft (most likely ex-USAF F-16A/Bs) are now being sought by the Philippine government.

5th Fighter Wing

Base: Mactan AB

Squadron: 6th Tactical Fighter Squadron

Equipment: F-5A/B

Poland

While not exactly an F-5 user, at least one F-5E did find its way into Polish hands, although the circumstances in which this occurred are not entirely clear. What is certain is that late in 1990 the unmistakable shape of an F-5 appeared near the PZL-Okęcie plant, which is opposite Warsaw's main civil airport, at Okęcie. According to Polish sources the (disassembled) F-5E (73-0852) had been in storage inside the

Institut Lotnictwa hangar at the factory since the early 1980s. Accounts of its arrival in Poland differ. One source states that the F-5, and an A-37, were handed over by the People's Republic of Vietnam for study and technical assistance, in the hope of keeping Vietnam's other captured aircraft airworthy. Another source states that the F-5 (which

The Polish F-5E is today on display at Cracow. The unique PZL MD-12 airliner, an Il-18 rival of 1959, is visible in the background.



was captured at Tan Son Nhut in 1975) was freely donated to Poland and arrived, by sea, in 1977. The aircraft was reassembled and ground tested (including its engines and guns) and, although it was never flown, it was taxied on at least one occasion (at Warsaw Bemowo). The F-5, still in its basic VNAF camouflage, arrived at Okęcie in February 1983 where it was disassembled once more, and it remained that way until its resurrection in 1990. Some have alleged that both it and the A-37 (which arrived at Okęcie in 1981) were used by PZL during

the development of the I-22 Iryda, but PZL firmly denies that anything was copied from the US designs. The partially restored F-5 is now on display at the Cracow Air and Space museum. Another 'mystery' VNAF F-5E (73-0878) is also on display at the Czech air force museum, at Kbely.

Little is known about the Czech F-5E, and how it came to reside in the Kbely museum, near Prague. It is seen here alongside the prototype Aero L-39 Albatros.



Saudi Arabia

Al Quwwat al Jawwiya as Sa'udiya/Royal Saudi AF

The F-5 is one of the linchpins of current Saudi defence plans. The air force operates a large fleet which is now scheduled for replacement and an international competition is heating up to win this important order. In 1971 Saudi Arabia acquired its first batch of F-5s, 20 F-5Bs and 30 F-5Es plus training equipment, for a total of \$117 million, under the Peace Hawk programme. Saudi F-5s were more sophisticated than most and came equipped with Litton LN-33 INS, ALQ-101/119 ECM pods and ALR-46 RWR. Saudi interest (and funds) also provided the impetus to fit the F-5 with the Maverick missile and its F-5Es now carry AGM-65A/B for ground attack and anti-shipping missions. Saudi F-5Es are also equipped with a refuelling probe, for use with the air force's KC-130 tankers. In late 1974 the RSAF placed a follow-on order for 40 F-5Es and 20 F-5Fs (Peace Hawk II) as part of an even larger US military aid package, and in 1976 two additional F-5Fs were acquired. Finally, in 1982, Saudi Arabia became the second customer for the RF-5E Tigereye when it ordered 10 aircraft, which were delivered in July 1985. At the same time attrition replacements were acquired in the shape of four F-5Es and a single F-5F (still under the auspices of the Peace Hawk programme).

By 1975 the F-5 had replaced the RSAF's Lightning F.Mk 53s in the attack role and by 1978 it was the air force's chief multi-role fighter. At the peak of its career (pre-Tornado), the RSAF had five F-5 squadrons, including one recce unit. No. 7 Sqn (the former weapons conversion unit) has now re-equipped with the Tornado IDS. Saudi F-5s are well-armed aircraft, dedicated to army close air support and able to carry

Still wearing its USAF serial, this RSAF RF-5E waits alongside an F-5E bound for Bahrain, at RAF Alconbury, during December 1986.

AGM-45 Shrike ASMs, GBU-10/12 LGBs and Rockeye CBUs. The US also supplied AIM-9Ps, and the F-5s were adapted to carry MATRA 550 Magic AAMs. During the Gulf War Saudi F-5s flew close air support missions during the closing stages of the ground war against Iraqi armoured units. One was lost to ground fire on 13 February 1991, bringing the number lost over the years to approximately 20.

Saudi plans to replace its F-5s began with the intention to acquire F-16s or F/A-18s on a one-for-one basis beginning in 1994. The Gulf War and Saudi Arabia's subsequent re-armament programme forced the F-5s replacement to join the back of the queue.



British Aerospace has long proposed a Hawk 100/200 purchase but now is offering a re-engined JAS 39 Gripen (fitted with EJ2000) that is armed with ASRAAM.

Unit: No. 10 Sqn
Base: Taif/Prince Fahd AB
Equipment: F-5E/F
Along with No. 17 Sqn, No. 10 was formed around the second batch of F-5Es delivered to the RSAF between 1976 and 1978.

Unit: No. 15 Sqn
Base: Khamis Mushayt
Equipment: F-5E/B
No. 15 handled initial F-5 training for the RSAF after its first aircraft were delivered.

Unit: No. 17 Sqn
Base: Tabuk/King Faisal AB
Equipment: RF-5E, F-5E/B/F
Along with No. 10 Sqn, No. 17 was formed around the second batch of F-5Es delivered to the RSAF between 1976 and 1978.

A reconnaissance nose similar to that carried by Canadian CF-5A(R)s was also developed for Saudi F-5Es. This picture shows the camera system still on test, by Northrop, in the United States.



Singapore

Republic of Singapore Air Force

The United States replaced the UK as Singapore's prime supplier of military aircraft from 1972, when A-4 Skyhawk deliveries began. In 1979 this relationship was cemented with an order (then worth \$113.2 million) for 18 F-5Es and three F-5Fs, along with 200 AIM-9J-1 Sidewinders. The arrival of the F-5 saw the transferral of Singapore's Hawker Hunters to the ground attack role. Between 1981 and 1983 an additional six F-5Es and three F-5Fs were delivered, while the RSAF also purchased its first ASMs in the shape of 200 AGM-65As. A second F-5 squadron was formed in June 1986 and six F-5Es were

added to it, following their delivery later that year. In December 1987 three additional F-5Fs were acquired. Even though the Northrop production line had closed, Singapore obtained five final F-5Es (between January and August 1989) which Northrop assembled from its spares stocks.

Singapore has invested heavily in upgrading its aircraft and its F-5Es have been fitted with the FIAR Grifo F/X Plus radar. However, this is the limit of its F-5 modifications thus far, and the F-5Fs are excluded.

F-5 Operators

Singapore Aerospace has converted eight F-5Es to RF-5E standard, to replace its Hunter FR.Mk 74s. The conversion programme began in 1990 with assistance from Northrop, and the 'new' RF-5Es can now carry the standard RF-5 camera pallets. Singapore Aerospace is also offering an F-5 upgrade for RSAF, and any other, aircraft. Israel's Elbit is alleged to be undertaking all

avionics integration. This includes a new avionics fit of HUD/WAC, laser INS, HOTA controls and air data controller. All are supported by a MIL-STD 155B database. Optional cockpit MFDs, multi-mode radar, FLIR and ECM can also be integrated. RSAF F-5Es have been retrofitted with FIAR Grifo F/X Plus radar. In 1994 Singapore acquired seven F-5Es from Jordan.

Spain

Ejercito del Aire Español/Spanish Air Force

As CASA built the bulk of the Ejercito del Aire's F-5 order, it is fair to say that the F-5 was the first (and so far only) supersonic aircraft to be built in Spain. Spain had considered building its own supersonic fighter in the form of the Hispano HA.300, but this was abandoned in favour of the F-104 (acquired in 1965). The F-5 replaced the last of Spain's F-86Fs, and its history dates back to 1967 when the decision was made to acquire 70 licence-built aircraft. This comprised 36 SF-5As and 34 two-seat SF-5Bs. Northrop first proposed that Spain acquire a new radar-equipped version of the F-5A. According to Northrop, the proposed radar's 20-mile (32-km) range would allow the F-5s to carry advanced versions of the AIM-9, not then an F-5 option. To simplify its local-production aspirations, Spain opted for standard F-5As.

Like all Spanish air force aircraft up to that time the F-5 was allocated a local designation, C.9. The C stood for *casa* (fighter) and '9' denoted that it was the ninth type acquired since 1939 (not strictly true, as several designations were reused; for example, both the Polikarpov I-16 and F-104G were designated C.8). The SF-5B was designated CE.9.

CASA imported the necessary jigs and machine tools to its plants at Seville and Getafe. Seville would produce the aft fuselages and engine mountings, while Getafe would supply the rest. The J85 engines came from General Electric in the United States, and avionics were US-supplied also. Northrop supplied the first eight aircraft in varying stages of completion. The first three were in component form, the next three were airframe shells and the final pair required only final assembly. The first Spanish-built F-5 (SF-5B, CE.9-001) made its maiden flight on 22 May 1968 and was delivered to the air force, along with nine other aircraft, on 19 June 1969. Deliveries were made to five squadrons and were complete by 1971. Half of the SF-5As were converted to SRF-5 (CR.9) standard by CASA, with a nose-mounted camera fit, but retaining the M39 cannon.

In 1988 CASA instigated a structural and avionics upgrade programme for the (then) 25 surviving SF-5As and SF-5Bs, along with Bristol Aerospace as its prime subcontractor. CASA is still a major supplier of F-5A/B parts worldwide. It had been intended to replace the F-4, F-5 and Mirage III with Spain's FACA (future combat and attack aircraft). The F/A-18 was acquired in 1985 and Spain is still an EF2000 partner, but both the F-4 and F-5 remain in service.

The last F-5s serve in the training role with the two squadrons of Talavera-based Ala 23. The upgraded F-5s fly lead-in fighter training for the F/A-18s.

Escuadrón 202

This was the first Spanish SF-5 unit and its first SF-5Bs entered service on 7 January 1970. Esc 202 was based at Morón until 1971, as part of Mando de la Aviación Táctica (MATAC) they provided coverage for southern Spain. Esc 211 remained part of Ala 21 until the wing was disbanded in October 1992. Most of its aircraft were scrapped. Esc 211 then re-equipped with Aviojets to act as a tactical training unit. It is expected to become the next Hornet unit with 24 ex-USN F/A-18s in 1996.



Unit: 141 'Falcon' Squadron

Equipment: RF-5E, F-5

Base: Paya Lebar

During 1995 all RSAF RF-5Es and a single F-5E were seen wearing the Merlin's head badge of No. 141 Squadron.

Unit: 144 'Black Kite' Squadron

Equipment: RF-5E (?), F-5E/F

Base: Paya Lebar

No. 144 began operations at Paya Lebar in 1985 and is tasked with a primary air defence role. It also undertakes the RSAF's nine-month F-5 OCC.

Unit: 149 'Shirkra' (Lynx) Squadron

Equipment: F-5E/F

Base: Tengah

Escuadrón 204

This unit was the second air force SF-5 unit but, like Esc 202, it was a short-lived one. When it moved from Morón to Talavera de la Real, along with its SF-5Bs, it renumbered as Escuadrón 732.

Escuadrón 211

Established when Escuadrones 202 and 204 became the formal air force training units, Esc 211 was one of the ground attack squadrons of Ala 21, based at Morón. As part of Mandó de la Aviación Táctica (MATAC) they provided coverage for southern Spain. Esc 211 remained part of Ala 21 until the wing was disbanded in October 1992. Most of its aircraft were scrapped. Esc 211 then re-equipped with Aviojets to act as a tactical training unit. It is expected to become the next Hornet unit with 24 ex-USN F/A-18s in 1996.

Escuadrón 212

As part of Morón-based Ala 21, Esc 214 was Esc 211's sister squadron. Esc 212 was the wing's reconnaissance unit and operated 18 SRF-5As and two SF-5Bs. In 1976 Esc 212 became Esc 464 and moved to the Canary Islands. Escuadrón 212 was reactivated in January 1982 when Esc 464 was disbanded, and returned to Ala 21, at Morón. Ala 21 was disbanded in October 1992 and six of its SF-5A/SRF-5As were transferred to Ala 23. The rest were scrapped.

Escuadrón 214

Esc 212 was briefly part of Ala 21 and operated the Hispano HA.220E Super Saeta and a small number of SF-5Bs. When the Saetas were retired, Escuadrón 214's SF-5Bs were transferred to the training wing (then Ala 73) and the squadron disbanded, in January 1982.

Escuadrón 731

This unit was formed in 1971 from the former Esc 202. At that time, like Esc 731, it had 15 SF-5Bs and a number of T-33s. Based at Talavera de la Real, near Badajoz, it operated 18 SF-5As and two SF-5Bs. Flying as part of the Ala 73 training wing it was later redesignated Esc 231 when Ala 23 became the fast jet training unit, and sole SF-5 operator.

Escuadrón 732

Esc 732 was formed in 1971 from the former Esc 204. At that time, like Esc 731, it had 15 SF-5Bs and a number of T-33s. Flying as part of the Ala 73 training wing it was later redesignated Esc 232 when Ala 23 became the fast jet training unit, and sole SF-5 operator.

Escuadrón 464

Esc 464 was allocated to the Mando Aéreo de Canarias (MACAN) and was based at Gando/Las Palmas, with SF-5As and SRF-5As. Established with some of the aircraft of the Esc 212, Esc 464 flew all three versions of the SF-5. It was disbanded on 14 January 1982 (and was re-established as Esc 212). Its place on the Canaries was taken by the Mirage F1s of Escuadrón 462.

Ala 23

Ala 23 is today the sole Ejercito del Aire F-5 operator, and has two component squadrons: Escuadrón 231 (formerly Esc 731) and Escuadrón 232 (formerly Esc 232). The wing provides fast-jet training and lead-in fighter training for the Hornets of Ala 12 and 31 and reports to Mando Aéreo del Estrecho (MAEST). Ala 23 is based at Talavera, in western Spain, and is the only unit at that base.

The wing can trace its lineage to 10 December 1953 when the Escuela de Reactores was activated. Ala 23's present strength is 22 F-5Bs and six SF/SRF-5As (those phased out by Ala 21 in October 1992). It has secondary tactical roles of CAS missions and as laser illuminators (with a laser designator in the rear cockpit) and the single-seaters are also tasked for target-towing (TDU-10/B target dart) for air-to-air gunnery practice. By the end of 1995, all 22 two-seat examples had received an upgrade by CASA, with the kits supplied by Bristol Aerospace Ltd of Canada, including avionics and structural strengthening – making the airframes good for an additional 4,000 flight hours.

Top: The Ejercito de l'Air took delivery of 70 SF-5s, including 34 SF-5Bs. All were delivered in a natural metal finish and many SF-5Bs remained that way throughout their operational lives.

Above: This was the standard tactical camouflage that later replaced the unpainted finish on SF-5s.

Left: Most, though not all, surviving upgraded SF-5s now wear this overall grey scheme. This Sidewinder-armed aircraft is an SF-5B of Ala 23.

Sudan

Silakh al Jawwiya as Sudaniya/Sudanese Air Force

Sudan was one of the quiet Cold War fields of confrontation and the regime in Khartoum changed its allegiance with regularity, not least after the left-wing coup of 1967. The air force, established with British assistance in 1955, received backing from Saudi Arabia, the USA, the USSR, China and Libya. Despite its largely Soviet-supplied line-up, in 1976 relations with the USA had improved to the point that Sudan applied for export approval. Its remaining Soviet advisors and diplomats were expelled and a Mirage III and Puma deal was also negotiated with France (which fell through). The US at first denied Sudan the F-5 but relented in 1978, offering 10 F-5Es and two F-5Fs, with Saudi funding. Two F-5Es were delivered in

October 1982 and the F-5Fs followed in June 1984 – though one of these crashed within a week. It is not known how many of the remainder were delivered (contrary to some sources it seems certain that at least two further aircraft were). Those that did survive were operated from Khartoum. An F-5F was sold to Jordan. Two Ethiopian F-5s defected during the Ogaden conflict, but the fate of these, and the remaining Sudanese aircraft is unknown.

Sudan is among the most secretive F-5 users, and the country is virtually now a pariah state among Western nations. These F-5Es are seen on delivery in June 1984.



Switzerland

Kommando der Flieger- und Fliegerabwehrtruppen/Swiss Air Force and Anti-Aircraft Command

The Swiss military depends on wartime conscription of a well-trained civil militia for the bulk of its strength. The air force has a relatively small peacetime establishment and a dispersed air base system that relies on many minimally equipped reserve bases and underground mountain caverns for protecting aircraft and personnel. The air force embarked on a fleet modernisation programme in the 1970s, and up to that time it had relied on the Hawker Hunter and Mirage III as its prime combat types. A lengthy search and evaluation lead to the 1976 signing of the Peace Alps deal with the United States, which covered the delivery of 66 F-5Es and six F-5Fs in a deal worth \$450 million. A substantial offset package was included for Swiss industry. While the first 13 F-5Es and all the F-5Fs were supplied by Northrop (by August 1978), the remaining single-seaters were assembled by FFA at its Emmen factory. So too was a follow-on batch of 32 F-5Es and six F-5Fs, ordered in 1981. The initial batch of this second order was delivered in 1983 in flyable condition by Northrop, before the first FFA-assembled aircraft was handed over a few months later. F-5s deliveries to the Swiss air force were completed by March 1985.

In October 1979 two squadrons (Nos 11 and 18) were commissioned, with 12 F-5Es each, as part of the Dubendorf-based surveillance wing. Two additional militia squadrons (Nos 8 and 19) transitioned from the Hunter in 1981. Aircraft from the second batch replaced de Havilland Venoms with two additional militia squadrons (Nos 6 and 13) and replaced Hunters with a third surveillance wing squadron (No. 1) – which in turn allowed more militia Venoms to be replaced by the surplus Hunters.

In 1985 Northrop AN/ALQ-171(M) ECM pods were ordered for the F-5 fleet (to be supplied by under licence by Daimo Victor in the USA), but the project was cancelled in 1989. Structural and avionics improvements have subsequently been carried out by the Swiss Federal Aircraft Factory (F+W). Swiss F-5Es were delivered as air defence fighters and armed with AIM-9Ps. With the withdrawal of the Hunter from service in 1994 (See *World Air Power Journal*, Vol. 20), some F-5s were retooled as ground attack aircraft armed with the AGM-65G Mavericks. The F-5 also took the place of the Hunter in the



Above: Carrying high-visibility markings vital for alpine survival, this F-5E was a participant in one of the Swiss air force's annual deployments to RAF Waddington, to use the BAe North Sea ACMI range.

national aerobatic team, the 'Patrouille Suisse'.

In peacetime the only operational unit is the Überwachungsgeschwader (surveillance wing), headquartered at Dubendorf. The many reserve (militia) units are called up only for deployment exercise and undertake the bulk of their flying from Dubendorf and Payerne with the surveillance wing's three regular squadrons. In wartime the airfield brigades (Flugplatz Brigade) of ground personnel required to support operations would also be called up.

Peacetime establishment

Flugwaffenbrigade 31 Überwachungsgeschwader

Unit: Fliegerstaffel 1 (Air Squadron 1)
Base: Dubendorf

Unit: Fliegerstaffel 11
Base: Dubendorf

Unit: Fliegerstaffel 18
Base: Payerne (Groupement Aerodrome 1)

Wartime establishment

Flugwaffenbrigade 31/Flugplatz Brigade 32 Fliegerregiment II

Component squadron: Fliegerstaffel 1
Base: Turtmann (Flugplatz Abteilung 6)

Component squadron: Fliegerstaffel 6
Base: Sion (Groupement Aerodrome 4)

Component squadron: Fliegerstaffel 8
Base: Meiringen (Flugplatz Abteilung 13)

Component squadron: Fliegerstaffel 11
Base: Alpnach (Flugplatz Abteilung 9)

Component squadron: Fliegerstaffel 13
Base: Meiringen (Flugplatz Abteilung 13)

Component squadron: Fliegerstaffel 18
Base: Payerne (Groupement Aerodrome 1)

Component squadron: Fliegerstaffel 19
Base: Alpnach (Flugplatz Abteilung 9)

1995 was the first year that the 'Patrouille Suisse' flew the F-5, instead of their long-lived Hunters.



F-5 Operators

Taiwan

Ching-Kuo Kung Chuan/Republic of China Air Force

Since its inception, Taiwan, the island Republic of China, has enjoyed constant US support. For many years the threat from mainland China, although constant, was not a sophisticated one and, as a result, Taiwan's defence forces were sizeable but not exactly modern. Large numbers of F-100s and F-104s were the backbone of the air force for many years. During the late 1960s 92 F-5As and 23 F-5Bs were acquired through the MAP and FMS programmes. Only 19 F-5As and 10 F-5Bs were FMS aircraft (i.e. paid for by Taiwan).

Approximately half these aircraft were transferred to South Vietnam prior to 1975 and the surviving aircraft were mostly transferred to two reserve units. As a temporary move 28 T-38As were transferred from the USAF to Taiwan to cover the loss of the F-5As. These were all returned (minus six losses). However, Taiwan is once again a T-38 operator having leased 40 aircraft, again from the USAF, to act as lead-in trainers for its F-16s. All reserve units have since been disbanded and some F-5As were converted into drones, at Mojave, in 1986.

In the early 1970s Taiwan initiated a programme of modernisation and self-sufficiency, particularly for its air force. In 1973 an agreement was struck for the local assembly of 100 F-5Es, known to the air force as the Chung Cheng. Production was undertaken by AIDC (Aero Industry Development Centre), which had been established in 1969 and had already built UH-1s for the army and PL-1A/B (Pazmany PI-1) light trainers for the air force.

In 1979 the United States withdrew all of its troops and cancelled the 1954 mutual defence treaty, in an attempt to improve relations with the Communist-led People's Republic of China. As a result Northrop support for the Chung Cheng programme was lessened, forcing a corresponding increase in locally-produced components (approximately 35 per cent). The air force order had, by then, risen to 162 F-5Es along

with 21 F-5Fs, and this was later increased by batches of 12, 24, 14 and 30 F-5Es plus 15 and 30 F-5Fs. The last of these was delivered in 1986, resulting in a grand total of 242 F-5Es and 66 F-5Fs. During the 1980s Taiwanese F-5s were updated with the addition of Litton ALR-46(V) 3 RWRs, Northrop AVO-27 laser designators and Tracor ALE-40(V)7 chaff/flare dispensers, along with AGM-65 Maverick ASMs and Paveway II LGBs.

Taiwan made repeated requests to the US for more advanced combat aircraft during the early 1980s, including the F-16, F/A-18 and even the F-4. The United States was prepared to offer the F-20 Tigershark as the solution to this 'FX' requirement, but this was halted by the increasing American rapprochement with China. Instead, in 1985 AIDC launched the IDF (Indigenous Defence Fighter) project, the Ching-Kuo, to replace its remaining F-104s and the F-5. The Ching-Kuo has now entered squadron service but production was suspended in late 1995 after serious flaws appeared in the fuel system. Also in 1995 the US decided to



Small numbers of F-5As are still in service in Taiwan, though many survivors were converted into drones during the 1980s.

release the F-16 (150 F-16A/B Block 20 aircraft) for export to Taiwan, while an order has also been placed with Dassault for 60 Mirage 2000-5s. As a result the F-5 is no longer Taiwan's most potent aircraft, although it is still by far its most numerous.

Taiwan's five F-5 wings fall under the control of Combat Air Command, and each wing typically has three squadrons of 18 aircraft. Wings also have three-digit shadow identities, for example the 8th TFW is also the 828th TFW. This cryptic system, adopted for security reasons, is now widely

known and can be explained thus – add the three figures of the 'shadow' identity and subtract 10 from any result exceeding 10 to give the true wing number. The 5th TCW (Tactical Combined Wing) is a fighter/reconnaissance unit that operates RF-104s (of the 12th SMS) alongside its F-5s. Training is undertaken by the 7th TFW, which also operates the air force aggressor unit, the 46th TFS. The aggressor unit was formed in 1988 and trains pilots against AFPLA tactics, with the help of Communist defectors.

1st TFW (443rd TFW)

Base: Tainan
Equipment: F-5A (?), F-5E
Component squadrons: 1st TFS, 3rd TFS, 9th TFS

4th TFW (455th TFW)

Base: Chiayi
Equipment: F-5E
Component squadrons: 21st TFS, 22nd TFS, 23rd TFS

5th TCW (401st TCW)

Base: Tao Yuan
Equipment: F-5E
Component squadrons: 17th TFS, 26th TFS, 27th TFS (plus 12th SMS with RF-104)

7th TFW (737 TFW)

Base: Taitung-Chih Hsiang
Equipment: F-5E, F-5F
Component squadrons: 44th TFS, 45th TFS, 46th TFS

8th TFW (828th TFW)

Base: Hualian (Hsinchu?)
Equipment: F-5E, F-5F
Component squadrons: 14th TFS, 15th TFS, 16th TFS



Above: This is an atmospheric view of an armed Taiwanese F-5F embarking on a night sortie.



Left: These brightly-marked F-5Es are operated by the 5th Tactical Combined Wing, at Tao Yuan.

Thailand

Royal Thai Air Force

Thailand obtained its first F-5s in 1967 as part of a reciprocal agreement with the United States that would see Thai troops entering the Vietnam War on the side of South Vietnam. Between 1967 and 1969 two F-5Bs, four RF-5As and eight F-5As were delivered followed by an additional 10 F-5As in 1971/73. The F-5s were based at Don Muang AFB, with the F-5As allocated to 13 Squadron and the RF-5As to 11 Squadron. These initial F-5s were all dedicated ground attack aircraft, but in 1978 17 air defence F-5Es and three F-5Fs were delivered to newly-established 102 Squadron. In 1981 a second air defence squadron was formed with an additional 17 F-5Es and three F-5Fs. These were augmented by two surplus Malaysian F-5Bs in September 1982. In June 1985 the air force began upgrading 20 F-5Es, fitting Litton LN-39 INS, ALR-46 RWR, ALE-40 chaff/flare dispensers and a GEC Avionics HUD/VAC. An additional 18 F-5Es received a HUD and INS only. For the ground attack mission Thailand acquired the General Electric GPU-5/A 30-mm cannon pod. The pod is carried on the

centreline station and was cleared for F-5 use in 1979. On delivery of the F-16 (in 1988) the F-5s were retooled for the anti-shipping mission. Ten mostly former-PACAF aggressor F-5Es were obtained as attrition replacements in 1988, at a cost of a mere \$500,000 each.

During 1977 the civil war in Campuchea

(Cambodia) spilled over Thailand's borders and in July RTAF F-5s flew combat missions against Khmer Rouge forces near Aranyaprathet. F-5s were later deployed to U-Tapao in April 1983 to stop Vietnamese incursions following the Vietnamese invasion of Campuchea (in 1978). Thai aircraft have regularly attacked Khmer

Rouge encampments, forced close to, and even over the Thai border by the Vietnamese, and in 1987 RTAF F-5s are alleged to have napalmed Vietnamese troops near the border. Prior to the Vietnamese pull-out, RTAF F-5s undertook regular 'show of force' overflights of the area.

Two former F-5 units, 102 Squadron and 103 Squadron, both part of 1 Wing at Korat/Nakhon Ratchasima AB, recently transitioned from the F-5 to new types. 102 Squadron received the L-39ZA Albatros in 1994 and transferred its F-5Es to 711 Sqn, replacing its OV-10Cs (which were transferred to 411 Sqn). 103 Squadron began to take delivery of the F-16 in 1988, giving up its RF-5As and F-5Bs to 231 Sqn, the following year.

In RTAF service the F-5 has been allocated the designation B.Kh.18 (F-5A) and B.Kh.18A (F-5E). The F-16 is the B.Kh.19.

With the recent arrival of a second batch of F-16s, the Royal Thai Air Force F-5 fleet has begun to contract. The F-5 was to have been replaced by the AMX, in which Thailand once showed a keen interest.



1st Air Division/6 Wing

Base: RTAFB Bangkok/Don Muang
Alongside its A310s, 737s, BAe 748s and Bell 412s, the Thai Royal Flight has an F-5E allocated to it for the personal use of one of the princes, an RTAF officer.

2nd Air Division/23 Wing

Base: RTAFB Ubon Ratchathani
Equipment: RF-5A, F-5A, B, E
Component squadron: 231 Squadron

3rd Air Division/4 Wing

Base: RTAFB Takhli/Nakhon Sawan
Equipment: F-5E/F
Component squadron: 403 Squadron

403 began to transition to the F-16C in September 1995. Its F-5Es will then transfer to 231 Sqn, replacing its current early-model F-5s.

4th Air Division/71 Wing

Base: RTAFB Surat Thani
Equipment: F-5E, F
Component squadron: 711 Squadron

This is the colour scheme in which Thai F-5Es were delivered – a three-tone grey/blue camouflage. The air force has begun to adopt US-style tail-codes. This 711 Squadron aircraft wears the 'SRT' code of RTAFB Surat Thani.



Tunisia

Al Quwwat al Jawwiya al Jumhuriyah al Tunisiyah/Republic of Tunisia Air Force

Tunisia enjoyed US military support as a result of Libyan-backed insurgency in the early 1980s. Prior to that, the air force's sole combat jet had been the F-86F, 12 of which were supplied by the US in 1969. The US later offered A-4s in 1973 (which were turned down) and 10 F-5Es and two F-5Fs, in 1974 (which were also passed over). Guerrilla activity from January 1980

brought an increase of US military support, including UH-1s and C-130s. Algeria approached France for combat aircraft and even requested F-15s from the US. Instead

This Tunisian air force F-5F is one of four delivered between 1984 and 1985, as part of Tunisia's first batch of F-5s.



a 1981 offer of four F-5Fs was accepted, followed by six (perhaps eight) F-5Es (worth \$200 million). Deliveries commenced in November 1984 and were completed in March 1985. Four ex-USAF F-5Es were later delivered in June/August 1989. Today the F-5Es form the air force's sole Escadrille de Chasse (fighter squadron), and partner an Escadrille d'Appui (attack squadron) of

Aermacchi MB.326s, based at Bizerte-Sidi Ahmed (to be replaced by Aero L-59s). Tunisia has expressed interest in a radar upgrade for its F-5s, and has examined the FIAF Grifo FX Plus.

In 1989 Tunisia received four additional ex-USAF F-5Es. They were painted in a different fashion but retained the same form of serial and continued the unit codes applied to the earlier aircraft. Tunisian F-5s are coded 'IA' to 'IP'.



Turkey

Türk Hava Kuvvetleri/Turkish Air Force

Turkish combat aircraft are committed to NATO's 6 ATAF and Turkey occupies a strategic position on Europe's southern flank. Despite this, Turkey's military was for many years poorly equipped and badly maintained. This, coupled with its antagonism towards Greece – its NATO partner – made Turkey one of NATO's less reliable members. Deliveries of Turkey's first F-5s began in 1965, to supplement and later supplant the large number of F-100s still in service (the last F-100s were not phased out until 1987, however). Under the MAP programme the US supplied 108 F-5s – 75 F-5As, 20 RF-5As and 13 F-5Bs – to the 1st and 3rd Tactical Air Forces. To supplement its original batch of RF-5As (flew by 163 Filo, Bandırma – which later became 162 Filo, after 1972 – and 192 Filo, at Balıkesir), Turkey converted up to 13 F-5As.

This well-weathered F-5A, from 5 Ana Jet Üs (5th Jet Base), Merzifon is carrying an early-model AIM-9B on its wingtip.

Turkey's F-5s, like much of its air force, have been gathered from a variety of sources as illustrated by this mixed-up F-5B.

to RF-5A standard. 184 Filo replaced its RF-84Fs with RF-5As from 162 Filo, in July 1976. 192 Filo was disbanded in June 1975 and transferred its RF-5As to 162 Filo. 162 Filo then acquired the 13 'new' RF-5As, and later added the ex-Norwegian RF-5As.

US aid was suspended for a time following Turkey's invasion of Cyprus in 1974, and during this period it is believed Libya transferred six F-5As and an F-5B to the THK. Assistance from NATO was soon restored (not least from West Germany) and large numbers of surplus F-5s were ultimately transferred to Turkey. In 1983 Norway transferred 11 F-5As, followed by 11 in 1985 and four F-5As and six RF-5As in 1987. Taiwan and the United States between them supplied six F-5Bs, while 60 NF-5As (only 34 flyable) were acquired from



the Netherlands. Deliveries of these aircraft began in June 1989, and were used to establish the new OCU, 133 Filo. During the late 1980s Turkey considered licence-production of the F-5E by TAI (having

The bulk of the operational NF-5s were allocated to 133 Filo, which acts as the THK's F-5 OCU, from its base at Konya.

previously considered the Alpha Jet and MB.339). Instead, Turkey opted to build the F-16, beginning in 1987.

Turkey's F-16 acquisition is part of a concerted effort at modernisation and the F-5 is slowly being edged out of service. However, the THK has such a huge spares holding that the F-5 is likely to remain in service for many years. Ex-Luftwaffe RF-4Es are also replacing the less capable RF-5As. The bulk of the fleet is tasked with ground



F-5 Operators

attack, and a secondary air defence role, although most are not AIM-9 capable.

A upgrade programme for Turkish F-5s has been much talked about (and much sought-after). In early 1995 it seemed likely that a decision would be made in favour of Elbit and Singapore Aerospace. The trail went cold until November 1995, when a Washington DC-based investment company, Triton Systems, began to solicit interest from Bristol Aerospace, IAI, Rockwell International, Sierra Technologies and Northrop-Grumman itself. Given US State Department approval, Triton hoped to broker a deal beginning in 1996 to upgrade 70 THK F-5As/Bs to act as lead-in trainers for the F-16. Of the total, 36 would be sold on to pay for the 34 THK-bound aircraft. However, as Bristol Aerospace has met with no success in selling its ex-CAF AUP CF-116s, it remains unclear if the Turkish upgrade can proceed on these grounds.

Operational F-5s come under the control of 2ci Taktik Hava Kuvveti Komutabligi (2nd Tactical Air Force/TAF). 2 TAF was created in 1972 and is headquartered in Diyarbakir, in eastern Turkey. 1 TAF has priority for F-16



deliveries and so 2 TAF is taking delivery of surplus F-4s to replace its F-104s. This will mean that the THK's older aircraft will all be centralised with 2 TAF. Until June 1994, 153 'Safak' Filo, at Merzifon, was part of 2 TAF and acted as the F-5 OCU, but that task is now the responsibility of 1 TAF's 133 Filo. 132 Filo, the operational training unit for F-5s (and F-4s), draws its aircraft from 133

Filo (and 131 Filo for F-4s). On 18 June 1994 the RF-5A-equipped 184 Filo, based at Diyarbakir, disbanded and passed on its aircraft to 151 and 152 Filos, where they returned to fighter standard. In December 1993 the 'Türk Yıldızları' (Turkish Stars) display team was formed, and made its first appearance outside Turkey at Kleine Brogel in September 1995.

The Konya-based 'Turkish Stars' first had six NF-5Bs, to which an additional solo display aircraft was added in 1995, followed by a single NF-5B.

1 TAF

3 Ana Jet Üs (3rd Jet Base), Konya
Squadron: 133 Filo (OCU)

Equipment: NF-5A, F-5A, F-5B,

Squadron: 132 Filo (tactical training)
Equipment: NF-5A, F-5A, F-5B

2 TAF

5 Ana Jet Üs (5th Jet Base),
Merzifon

Squadron: 151 Filo

Equipment: F-5A, RF-5A

Squadron: 152 Filo

Equipment: F-5A, RF-5A

United States of America

United States Air Force

The USAF's initial contact with both the F-5A and F-5E was limited to evaluating the aircraft and to providing training for the air and ground crew from customer nations. F-5As were delivered to customers in silver-painted (not natural metal) finish. To this the USAF originally added a large serial on the tail, 'US AIR FORCE' on the sides of the nose, 'USAFA' above the starboard wing and below the port, with star and bar national insignia on the intakes and above the port and below the starboard wing. Following the fashion of the time, a large buzz number was painted on the centre fuselage sides, with an FA-type designator and the last three digits of the serial.

Aircraft participating in Skoshi Tiger (the USAF's combat evaluation of the F-5 in Vietnam) were specially camouflaged in tan and two tones of green with grey undersides. Buzz-numbers, 'USAFA' and 'US AIR FORCE' legends were removed, and the stars and bars were reduced in size. The serial too was made smaller, and was painted below the letters 'USAFA'. These tail markings were applied in black, hardly showing against the camouflage. Out of the operational area camouflaged aircraft soon gained tailcodes (usually in white), with serials presented in the same colour, with the last three full size and the first two digits half size below the half-size letters AF. The half-sized letters and numerals were often painted black. A Tactical Air Command shield was usually painted on the tailfin, while squadron and wing badges often decorated the nose. Squadron or flight colours usually appeared in a narrow band across the tailfin, with canopy rails often being painted the same colour.

Some of the earliest F-5Es were returnees from Vietnam, or aircraft intended for the VNAF, so these were similarly decorated, sometimes with the tailcode and serial in black. Most USAF F-5Es returned to silver finish, however, with large serials and 'USAFA'/'US AIR FORCE' titles in the same locations as on the first As and Bs. Buzz

numbers did not reappear. Many silver-painted aircraft of the 425th TFTS also received prominent chordwise yellow bands (thinly outlined in black) across the fin and wingtips, with a diagonal sloping band around the rear fuselage. These markings were extremely reminiscent of those applied to USAF Sabres during the Korean War. The same scheme was worn by some of the F-5Bs which served alongside the F-5Es, pending the availability of the F-5F. The yellow-banded aircraft had unit colours restricted to the canopy rails, but other silver aircraft had narrow fin bands too. Some early aircraft had much broader yellow bands than were eventually adopted as standard.

F-5Fs were mainly delivered in a two-tone grey air superiority camouflage, similar to that applied to contemporary South Korean aircraft. The final colour scheme for the F-5Es and F-5Fs used in the training role was an overall air superiority grey, at first with full-colour national insignia and 'US AIR FORCE'/'USAFA' titles and a large TAC badge. The matt black anti-dazzle panel extended back to cover the canopy surround. The grey aircraft eventually received toned-down stars and bars in stencilled outline form only, with no 'USAFA' or 'US AIR FORCE' titles and with tailcodes in black below a much reduced TAC shield. The 'US AIR FORCE' fuselage legend was generally phased out during the mid-1980s, while wing tailcodes were being phased in. The changeover was mainly complete by 1987. By this time the aircraft also carried a tiger's head badge on the rudder, applied in two shades of grey. The requirement for training customer aircrew had disappeared by 1989, and the 425th TFTS disbanded.

The USAF's 4503rd TFS took its 12 F-5As to Southeast Asia in October 1965, for its Skoshi Tiger evaluation. On completion, the 4503rd became the 10th FCS for combat duties.



Above: The 425th TFTS was assigned to Luke AFB, but was based at Williams to take advantage of the latter's T-38 facilities.

Below: The brightly-painted F-5Es of the RAF Alconbury-based 527th AS provided valuable combat training for USAFE fighter units.



As well as their training role, the USAF's F-5Es fulfilled a vital role in providing dissimilar air combat training (DACT) to front-line fighter units. Dedicated aggressor squadrons were formed in the wake of a disastrous decrease in the USAF's kill:loss ratio in Vietnam – the USAF seemed to be on the way towards losing the fighter-versus-fighter war over Vietnam to the latest generation of MiG-21s. The reasons were twofold: a serious lack of proficiency, and the use of unsuitable aircraft, weapons and tactics. The Navy's 'Top Gun' programme had turned around US Navy F-4 combat results in Vietnam and clearly showed the way forward for the USAF. It resulted in major changes in USAF ACM training. As an interim step, the USAF's Fighter Weapons School suspended instructor training and instituted the Top Off ACM training course for aircrew deploying to Vietnam. A dedicated aggressor squadron was instituted during 1972, with T-38s borrowed from Training Command as interim equipment, pending the delivery of F-5Es in 1975.

The success of the first aggressor squadron, and the availability of F-5s that should have gone to Vietnam, led to the formation of further units, another at Nellis and one more each with PACAF and USAFE. These were initially designated as TFTAS (Tactical Fighter Training Aggressor

Squadron) and later simply as AS.

The aggressor squadrons adopted role-specific colour schemes almost from the start, although these were centrally laid down and were not applied at unit level, as they tended to be in the US Navy. Two-digit nose codes were applied to most aggressor F-5s, and these coincided with the last two digits of the aircraft serial number. Three-digit codes were used where there was any duplication. On US Navy and Marine Corps adversary F-5s such codes were entirely random. A number of other colour schemes were experimented with (again as a result of central direction, not unit improvisation), including a hard-edged Ferris camouflage and a number of air superiority grey schemes.

International conventions make it necessary for military aircraft to carry their national insignia, although for the aggressors this directly contradicted their desire to make their aircraft look as much like 'hostiles' as possible. Aggressor aircraft had their star-and-bar national insignia reduced in size and relocated to a less conspicuous position on the rear fuselage, adjacent to the wing trailing edge. The aggressor units were among the first to apply the star and bar in toned-down or stencil form. The words 'US AIR FORCE' were applied immediately forward of this, in small letters.

By the late 1980s it was felt that the F-5E could no longer adequately replicate the threat, and F-16s were procured. Since the F-16 was already in the inventory this removed the 'dissimilarity' from the aggressor's justification, and the force fell victim to budget cuts, apart from a tiny core unit at Nellis which provided DACT for Red Flag exercises.

10th Fighter Commando Sqn

When the Skoshi Tiger evaluation formally ended the unit was expanded in size (to 18 aircraft) and was redesignated as the 10th Fighter Commando Squadron in March 1966, assigned to the 3rd TFW at Bien Hoa. This was to have been the first of a three-squadron wing requested by TAC, but further deliveries were to the VNAF itself, beginning when the 10th handed over its F-5s to form the nucleus of the 522nd Fighter Squadron, VNAF. The 3rd TFW was destined to fly F-100s and A-37s until re-equipped with the F-4 Phantom.

26th Aggressor Sqn

The 26th TFTAS was based at Clark AB as part of the 3rd TFW. The squadron quickly replaced its T-38s with F-5Es, including six embargoed aircraft intended for the Ethiopian air force. The unit never had more than a dozen F-5Es on charge. Its aircraft used yellow-outlined red codes. The squadron moved to Kadena to re-equip with the Block 30 F-16C. Five F-16Cs were sent to Osan during the move from Clark to Kadena, but the 26th AS disbanded before it could receive them.

64th Aggressor Sqn

The 64th Fighter Weapons Squadron (later the 64th Tactical Fighter Training Aggressor Squadron and eventually the 64th Fighter Weapons Squadron) was formed in October 1972, as part of the 57th Fighter Weapons Wing (then the 57th Tactical Training Wing) and was operational by June 1973. The squadron decorated its aircraft with two-digit red codes, outlined in yellow. F-5E operations were run down during 1988 and 1989. The unit finally stood down on 1 October 1990, having briefly flown the F-16. The 440th TG then established an Adversary Tactics Division with six F-16s.

65th Aggressor Sqn

The 65th AS was established in October 1975. Although aircraft from both Nellis-based aggressor units were effectively pooled, the squadrons were theoretically assigned their own aircraft. The 65th AS decorated its F-5Es with blue 'Bort' numbers. A pale blue was used initially, with a fine white outline, but many aircraft later received almost black codes, outlined in yellow. The 64th and 65th AS ran down their F-5 operations simultaneously, although the 65th was destined to deactivate, while the 64th went on for a brief life equipped with the F-16. The pool of F-5s in use dwindled from 39 aircraft in mid-1988 to 18 in April 1989. Twelve departed for Brazil in August 1988 alone. The commander, Lieutenant Colonel Mike Koerner, left his last aircraft (with bogus 65 code and 57 FW tail markings) on the Nellis gate. The F-5E made its last flight in aggressor service on 7 April 1989.

425th Tactical Fighter Training Sqn

The TAC-assigned 425th TFTS was formed by redesignating the 4441st CCTS. It was assigned to the 58th TTW at Luke from 15 October 1969, although it was based at nearby Williams AFB for commonality with the T-38s of the 82nd FTW. F-5As began to give way to F-5Es from 4 April 1973. F-5Bs remained in service for much longer than the F-5As but were eventually supplanted by F-5Fs. The squadron was reassigned to

the 405th TTW in August 1979, when this unit took over as the RTU for the F-15. The 405th remained at Luke and inherited the 'LA' tailcode, while its offshoot remained at Williams. The 425th deactivated in September 1989, passing its aircraft on to the USAF's aggressors, to Honduras and to Brazil. It later converted to the F-16 at Luke Air Force Base as an FMS training unit.

527th Aggressor Sqn

The 527th was the last of the USAF's aggressor squadrons to form, standing up at RAF Alconbury as part of the 10th TRW on 1 April 1976. The first eight aircraft arrived aboard a USAF C-5 soon afterwards. The squadron rapidly built up to a strength of 20 aircraft. Its task was to provide DACT for USAFE fighters, and it spent much of its time fighting Bitburg- and Soesterberg-based F-15s over the North Sea. A detachment was also established at Decimomannu for DACT support of USAF fighters using the ACMI range there. Budget cuts ended USAF flying at 'Deci' in early 1988, and the 527th's detachment in Sardinia came to an end. The squadron's aircraft used a mix of black- and red-coded aircraft (these codes had yellow outlines) with a handful wearing black-outlined powder blue codes. Eight of the unit's F-5Es went to VFA-127 at NAS Fallon, while the others went to Davis-Monthan or directly to foreign customers. Ten aircraft went to RAF Kemble between May and September 1988, where eight were immediately prepared for Tunisia and Morocco, departing for their new homes between June 1989 and March 1990. The other two followed in 1990 and 1991. One further ex-527th AS F-5E arrived at Kemble in November 1991 and was delivered to Morocco. The 527th moved to Bentwaters and the 81st TFW, and re-equipped with the Block 32 F-16C in January 1989, but was destined to have a short life as an F-16 unit, deactivating in 1990.

4441st Combat Crew Training Sqn

Activated in December 1963 to train customer nation's aircrew and ground crew on the F-5, the 4441st received its first F-5Bs on 30 April 1964, receiving its first F-5As (retrofitted with nose guns) in August. The squadron was initially equipped with 12 aircraft including five two-seaters. The first class of 12 pilots (six Iranians, four Koreans and two USAF MAAG pilots) convened in September 1964 and completed its training in March 1965. Four extra F-5s were added in 1966 in anticipation of a requirement to train the USAF pilots needed to man the aircraft everyone expected TAC to receive for use in Vietnam. In the event, the 10th Fighter Commando was to remain the only operational USAF Freedom Fighter squadron, and the 4441st's extra aircraft absorbed the growing requirement for training foreign pilots. The 4441st was redesignated as the 425th TFTS in October 1969, remaining at Williams with the primary role of training foreign pilots for the F-5, although the new unit officially reported to the 58th TTW at Luke AFB.

4503rd Tactical Fighter Sqn (Provisional)

The 4503rd TFS was formed specifically to conduct an operational evaluation of the F-5 in Southeast Asia under the codename Skoshi Tiger, which was initiated on 26 July 1965. The 4503rd was formed three days later. Training began on 2 August 1965 and 12 modified aircraft were delivered to the unit by 11 October. The unit left Williams for South Vietnam on 20 October 1965, arriving at Bien Hoa on 23 October. The 4503rd moved to Da Nang after 68 days for Phase II of the evaluation, moving back to Bien Hoa on 1 February 1966. In March 1966, following the close of the Skoshi Tiger evaluation (which came to an end on 19 February), the 4503rd was redesignated as the 10th Fighter Commando Squadron, reflecting its shift from evaluation to operational status.



United States Navy

By the beginning of 1996 VFA-127 was the last of the US Navy's F-5E adversary units, but was slated for disbandment in March that year.

although it did gain responsibility for providing OCF (Out-of-Control Flight) training for F-14 aircrew, using newly acquired T-2C Buckeyes. In 1985 VF-43 gave up its F-5Es in favour of leased IAI F-21 Kifirs, but regained them in 1989 after the 1988 return of the Israeli aircraft. The F-5Es operated alongside A-4s, T-2s and F-16Ns, all using the callsign AMBUSH. VF-43 was disestablished in September 1993, turning over its responsibilities to VFC-12, a reserve squadron equipped with the F/A-18.

VF-45 'Blackbirds'

VF-45's 'Blackbirds' nickname and badge date back to a 1951 deployment aboard the carrier *Oriskany*, with four regular and 20 reserve pilots, a number which reminded all concerned of the children's nursery rhyme, and of the blackbird's tenacious defence of its nest and offspring. The squadron took over the aircraft and responsibility of the VF-171 DACT detachment in June 1984, effectively becoming a full-time adversary unit. This was recognised by a redesignation to VF-45 on 6 February 1985. DACT was formally added to the squadron's responsibilities by the CNO on 16 August 1976, and became a dedicated adversary unit on 1 October 1984. Its primary role was then to provide adversary training for Atlantic Fleet light attack and attack squadrons, but it later gained the responsibility for providing DACT for all aircraft using the ACMI range at its home, NAS Key West. With the introduction of the F/A-18, VF-45 was tasked with developing a version of the F-14 FFARP for the new community, and this was dubbed SFARP (Strike Fighter ACM Readiness Program). VF-45 gained F-16Ns in 1987 and by 1989 had 12 (including two TF-16Ns) alongside 12 Skyhawks. During most of 1988 and 1989 VF-45 loaned six of its F-16Ns to the 'Challengers' of VF-43. To make up for the loss of some of its F-16Ns to VF-43, F-5Es



Above: This pseudo-Iraqi colour scheme was applied to a VFA-127 F-5E, which also wore NAS Fallon's 'NJ' tailcode.

Below: VFA-127's F-5Es may be retained by VFC-13 when it takes the place of the 'Desert Boeys' at Fallon, in March 1996.



F-5 Operators

were added in December 1989. The last F-16Ns flew out in December 1994, prematurely retired due to their structural problems. In November 1995, VF-45 still had seven F-5Es and two F-5Fs, but the squadron was due to disestablish in March 1996, leaving East Coast adversary training to the reservists of VFC-12 and their F/A-18s. The squadron's F-16Ns were withdrawn in December 1994.

VF-126 'Bandits'

As VA-126, the squadron became an instrument RAG in 1960, and was redesignated VF-126 in October 1965. The squadron assumed a DACT role in February 1970, for which it received four single-seat A-4s. In 1980 VF-126 developed the TAP (Turnaround ACM Program) for Pacific Fleet Tomcat squadrons, which was standardised with what VF-43 was doing on the East Coast when it became a FFARP. In 1981 VF-126 handed over its instrument training responsibilities to VA-127 to become a dedicated adversary unit. The squadron acquired a T-38 and three F-5Es from VF-43 when that unit re-equipped with the F-21 Kfir. The F-5Es moved on about 1990. VF-126 itself was disestablished in September 1993 at NAS Miramar, handing over its responsibilities to the F/A-18-equipped VFC-13.

VFA-127 'Desert Bogeys' / 'Cylons'

VA-27 was first the West Coast A-4 RTU, and from July 1975 was an instrument RAG. It gained a DACM role in November 1975 and lost its instrument training role



United States Marine Corps

By the 1980s, it was clear to the USMC brass that its squadrons were not able to secure the services of Navy adversary units as often as they might have liked, and they decided to form their own. The 'Snipers' therefore formed in 1986 as a reserve adversary squadron, equipped with leased IAI Kfirs. Its reservist pilots are all ex-USMC fighter pilots who have graduated from 'Top Gun' on the F-4 or F/A-18, and most are ACT instructors. Even the lowest-timed

pilots have 1,800 flying hours and high-time pilots have more than 4,500. The high cost of the Kfir maintenance contract led to the type's replacement by F-5Es in 1989. The aircraft wore a variety of colour schemes, some applied at unit level and others inherited from previous users. The majority of aircraft were in various blue/grey camouflage schemes, one exception in standard USAF 'Flogger' finish being derisively known as the 'Neon Earthpig'.

entirely in October 1983. The unit's primary role was to provide adversary training for West Coast light attack and attack squadrons, instituting a SFARP for Lemoore's Hornet community in 1985. In 1987 the squadron was redesignated VFA-127, moved to NAS Fallon and took over the F-5Es replaced by F-16Ns with VF-45 and the NFWS. In late 1988 VFA-127 received eight more F-5Es from converting USAF aggressor units, doubling its Tiger strength. One aircraft was painted semi-gloss black overall, with red titles, in a morale-boosting move intended to commemorate the fact that the squadron was then the US Navy's only F-5 user. The squadron acted as the 'Home Field' adversaries for Fallon's massive TACTS range, and for the co-located Strike Warfare Center. VFA-127 replaced its A-4s with F/A-

18s in 1992, but retained F-5Es. By November 1995 VFA-127 had 13 F-5Es and a single F-5F on charge, but was due to disestablish in March 1996, at its NAS Fallon home. VFC-13 was due to move in from Miramar to replace it and perhaps to take over the F-5Es, losing its current F/A-18s.

Naval Fighter Weapons School

The Navy Fighter Weapons School ('Top Gun'), at NAS Miramar, was initially formed as part of VF-121, the Pacific Fleet Phantom RAG. Its role was to establish a programme to give experienced F-4 aircrew instruction in ACM to enable them to return to their units as instructors. The first class began in

A 'Snipers' F-5E departs MCAS Yuma, in 1992. While the Marines' aggressor force has never been large, its future looks secure, as long as the F-5 remains a supportable type in the United States' inventory.

VMFT-401 'Snipers'

VMFT-401 formed in 1986 as a reserve adversary unit equipped with IAI F-21A Kfirs leased from IAI. The F-21As flew their final sortie on 24 September 1989 and were then shipped to NAS Norfolk for disassembly and return to Israel. With the departure of its Kfirs, VMFT-401 received an initial batch of ex-64th and -65th AS F-5Es from storage at Davis-Monthan. By November 1995 the squadron had 11 F-5Es and a single F-5F, based at MCAS Yuma with no planned replacement in sight.

March 1969 and classes have continued to be run ever since. The school achieved its independence (from VF-126, to which it had transferred) in 1972. The unit gained a handful of T-38 Talons in 1972, and then in 1975 took advantage of the windfall of F-5Es intended for use by Vietnam but never delivered. 'Top Gun' the school provided aircrew, facilities and aircraft for the making of Top Gun the movie. Among the latter were three hastily resprayed F-5Es and an F-5F, whose black finish and red fin stars converted them into the 'enemy' MiG-28s. This was one of the last jobs for the 'Top Gun' F-5s, which were replaced by F-16Ns during 1987. The F-16Ns were withdrawn from use during January 1995, and were flown out for storage in February 1995, leaving only F/A-18 Hornets and F-14 Tomcats.

Venezuela

Fuerzas Aéreas Venezolanas/Venezuelan Air Force

As a result of its considerable oil wealth, Venezuela has been able to afford one of the best-equipped air forces in South America, despite its small size. For example, in 1952 it became the first South American nation to order a jet bomber, in the shape of the Canberra. Its relationship with the F-5 began in 1972 when 16 CF-5As, which had been in storage along with two secondhand CF-5Ds from the CAF, were purchased from Canada. They replaced F-86 Sabres. The F-5s were delivered to the FAV in two groups between 11 February and 11 June 1972. The funds received allowed a new batch of CF-5s to be built for the CAF. Two new-build CF-5Ds were also delivered to Venezuela on 27 January 1974.

Venezuela gave the local designations VF-5A/B to its aircraft and converted two VF-5As to reconnaissance RVF-5As. During 1982 Venezuela decided against a BAe Hawk purchase and attempted instead to

acquire 15 CF-5As and four CF-5Ds, to replace the F-86Ks of No. 35 Sqn. This bid was unsuccessful, and fatigue problems forced the FAV to retire its original VF-5 force in May 1990. However, more F-5s were acquired, in the shape of a single NF-5A and six NF-5Bs, from the Netherlands in February 1992. These deliveries have released the 13 surviving VF-5As and single VF-5D for refurbishment by Singapore Aerospace. In a programme initiated in May 1991, a VF-5A and VF-5D were delivered to Paya Lebar, returning to Venezuela in May 1993. The other aircraft are being rotated through the same process, beginning in May 1994.

The Venezuelan F-5 fleet has been battered by time and hostile action but the surviving aircraft are now being overhauled in Singapore.

On 27 November 1992 elements of the FAV led a coup against the Venezuelan government. Rebel Mirage IIIs, Tucanos and OV-10s attacked civilian and military targets, while coming under attack themselves from 'loyal' FAV F-16s. The VF-5 force was scattered due to its ongoing upgrade programme and played little part in the fighting, although one aircraft did scramble to defend Barquisimeto AB. Three VF-5As

were destroyed on the ground by rebel Mirages and Broncos. The coup attempt failed.

Grupo de Caza No. 11

Component squadron: Escuadrón 36
Base: BA Teniente Vicente Landaeta, Barquisimeto
Equipment: VF-5A/D, RVF-5A, NF-5A/B



Vietnam

Vietnamese Air Force

By 1966, the VNAF was urgently requesting that it be given jet aircraft. The Air Force Advisory Group recommended to the DoD that the VNAF should receive the F-5. Robert McNamara, the Secretary of Defense, accepted the recommendation, and the first class of VNAF pilots (all experienced A-1 Skyraider pilots from the 522nd Fighter Squadron) were sent to Williams AFB for conversion training in August 1966. The Vietnamese pilots began flying F-5s transferred from the 10th FCS in April, and the 522nd FS was activated on 17 April. A formal ceremony marking the activation was held on 1 June, by which time 17 F-5A/Cs and a pair of F-5Bs were on charge. Air Marshal Nguyen Cao Ky had already had himself checked out in the new fighter.

Led by Lieutenant Colonel Duong-thien-Hung, the 522nd was an elite unit and frequently deployed to other airfields for operations. While the glamour of having a supersonic fighter was highly prized, the

A 3rd Air Division, VNAF, F-5A stands ready at Da Nang with a load of Mk 82 bombs.

F-5 itself proved a disappointment, especially with regard to its bombing accuracy, and the planned second squadron was not formed.

The defeat of an attempted North Vietnamese invasion in March 1972 led directly to the 1973 ceasefire, and to the withdrawal of US forces. With the USAF gone, Vietnam suddenly had to look after its own air defence, and turned to the F-5. Vietnam's own forces were rapidly expanded to fill the gap, not least through Operations Enhance and Enhance Plus. These supposedly brought to the VNAF the status of being the fourth largest air force in the world, with 2,075 aircraft, 61,147 men and 65 squadrons. It is impossible to state with much certainty how many F-5s were received by Vietnam, since USAF, Northrop and post-war figures differ markedly. Nor is it possible to go into much detail about the various units which operated the F-5s.

The 1st Air Division controlled the 41st Tactical Wing at Da Nang where the 538th



Fighter Squadron re-equipped with F-5s before the war's end. The 3rd Air Division controlled the 23rd Tactical Wing at Bien Hoa, always the main operator of the F-5. The wing included the 522nd, the 536th, the 542nd and the 544th Fighter Squadrons. These wore three-digit tailcodes with a two-digit squadron designator ('HJ' for the 522nd, 'HQ' for the 536th, with the other units using 'HB', 'HR' and 'HZ'). The 3rd Air

Division's 23rd and 63rd Wings used a black and yellow checkered tail band on their aircraft. One of the Bien Hoa units included some of the RF-5As delivered, but others reportedly flew alongside EC-47s, RT-28s and U-6s with the 716th Reconnaissance Squadron at Tan Son Nhut. The 6th Air Division controlled the 72nd and 82nd Tactical Wings at Pleiku and Phu Cat, with the latter airfield housing the F-5s of the

540th Fighter Squadron. By 1974 it was estimated that the VNAF fielded four squadrons with F-5As and RF-5As (using 82 aircraft, with 36 more first-generation Freedom Fighters in storage) and three squadrons of F-5Es.

The F-5E had been developed with the needs of the VNAF in mind, and large numbers (an estimated 118) were delivered under Operation Enhance Plus. Some of these were diverted from Iranian contracts, and arrived at Tan Son Nhut in desert camouflage. Others arrived in silver, and these remained uncamouflaged until the end of the war, when some escaped to Thailand. The intention was that these leased aircraft should be returned to their owners as Vietnam's own order for 126 F-5Es was delivered. The F-5E required more skilled ground support than the F-5A, due mainly to its radar-based fire control system, and proved less available than the earlier versions. The 536th Fighter Squadron was the first to re-equip with the F-5E, on 10 June 1974.

Air defence was controlled by the TACC

at Tan Son Nhut, with the country divided into a Northern and a Southern Air Defence Sector. The Northern Sector had control and reporting stations at Da Nang (Panama) and Pleiku (Peacock), while in the South were Ban Me Thuot (Pyramid), Saigon (Paris) and Bin Thuy (Paddy).

North Vietnam continued to build up its forces for a final assault on the South, encouraged by a lack of US response to repeated treaty violations. Four RF-5As were lost to ground fire trying to monitor activity on the Ho Chi Minh Trail, and the North Vietnamese sent SAMs and AAA into the South, challenging the VNAF's control of its own airspace in the border regions. Small attacks were followed by a massive attack on Ban Me Thuot in the Central Highlands on 9 March 1975. An orderly withdrawal to regroup and counter-attack turned into a rout, and resistance in the north crumbled in the face of enemy pressure.

Da Nang fell at the end of March and Phu Cat followed only days later. F-5s from both bases fled to Bien Hoa to join the 23rd



Seen in a Bien Hoa revetement on 15 April 1970, this VNAF F-5A was assigned to the 23rd Tactical Wing.

Tactical Wing. On 8 April one of the wing's pilots bombed the Presidential Palace before defecting to an airfield held by the North, and on 28 April F-5s failed to catch the captured A-37s which bombed Bien Hoa. Nor was Ky successful in his attempt to form an elite unit of F-5s to start taking the war to the enemy.

The fall of Xuan Loc on 22 April left Bien Hoa unsupportable, although operations continued until 28 April when Bien Hoa fell. Several F-5Es were damaged or destroyed in a Vietnamese mortar attack, but all serviceable aircraft escaped. The remnants of the 23rd Wing pulled back to Tan Son Nhut. About 93 of the 109 surviving F-5s remained serviceable, but they were hampered by the inability of ground

Bomb shackles empty, a 3rd Air Division F-5B taxis in after a mission. VNAF F-5s were active until the very last days of the war, in 1974.

commanders to use air power effectively, by the destruction of South Vietnam's radar-based air defence system, and by plummeting morale. In the last few days before Saigon fell, 26 F-5s fled to U-Tapao in Thailand, eventually being shipped back to the USA via Guam, undertaking the first stage of the journey as deck cargo aboard the USS *Midway*.

Despite the rush to pour equipment into South Vietnam, of the F-5Es ordered by the VNAF many remained undelivered when the country fell. They were taken over by the USAF and used in the aggressor role, as were many of the F-5Es which fled to Thailand in the closing days. Eighty-seven F-5As and F-5Bs, and 27 F-5Es, remained in South Vietnam, however, and these were taken over by the victorious North.

Vietnamese People's Air Force

The victorious North Vietnamese captured an estimated 87 F-5As and F-5Bs, and 27 new F-5Es, most of which were immediately pressed into service with the air arm of the newly reunified nation. A handful were passed on to the USSR and (perhaps directly) to some of its client states for technical examination and evaluation. Aircraft certainly ended up in both Czechoslovakia and Poland. In the immediate aftermath of the war, it seems

Below: Many captured ex-VNAF F-5s, such as this battered F-5E, now grace war memorials in the People's Republic.

that F-5 squadrons were scattered through North Vietnam's fighter force, with several composite squadrons operating both F-5s and MiG-21s. One of these was reportedly based near Hanoi. This caused severe logistical difficulties and the F-5s were eventually concentrated in the 935th Fighter Regiment, part of the 370th 'Hai Van' Division at Da Nang. By 1978, the F-5 was still in widespread service, and it was reported that 'waves' of F-5s were used

Right: Before they were relegated to museum pieces, F-5s, like this F-5B, formed an important part of the People's Air Force.



during the invasion of Kampuchea. The increasing difficulty of maintaining the F-5s led to cannibalisation, which in turn steadily reduced the numbers in service, and the proportion of F-5s to MiG-21s within the 935th Regiment steadily declined. Nevertheless, three F-5s, in full North

Vietnamese markings, participated in the massive flypast over Ho Chi Minh City (formerly Saigon) to commemorate the 10th anniversary of the end of the war in 1985. Some F-5s may remain in storage, but it seems more likely that all survivors were passed to Iran and Ethiopia for spares.



Yemen Arab Republic (North)

Yemen Arab Republic Air Force

When the Soviet Union transferred its allegiance from North to South Yemen (The People's Democratic Republic) in the mid-1970s, it opened the way for the YARAF to acquire an eclectic mix of Western and Eastern aircraft. With US approval, the Saudi government transferred four F-5Bs to North Yemen which also requested 12 F-5Es to replace its unserviceable MiG-17s. As

border skirmishes increased between the two Yemens, in 1979 the RSAF transferred approximately 12 F-5Es that it had acquired for Egypt to the YARAF. Taiwanese pilots were recruited until Yemen could train its own personnel, and Taiwan also supplied technical support. Relations with Moscow subsequently warmed to the extent that the F-5Es were flying from Sana'a, the capital,

alongside Soviet-supplied Su-22s flown by Cuban pilots.

In May 1990 the two Yemens united as the Yemen Arab Republic, resulting in a Unified Yemen Air Force. At that time the F-5E/Bs were based at Sana'a, as one of the air force's eight otherwise Soviet-equipped fighter squadrons. In May 1994 a major civil war broke out between the two groups when southern secessionist forces supported by Saudi Arabia fought the Iraqi-backed government. Iraqi personnel flew the surviving five (of 12) MiG-29s delivered to the south by Moldova, but captured by

the north, on behalf of President Ali Abdullah Salah's government forces. The MiGs had been flown, for the South, by Russian and perhaps South African mercenaries.

The Yemeni F-5s were believed to be largely unserviceable when the fighting broke out, but they did appear on TV reports of the fighting and one was claimed shot down by the south. The fighting ended in July 1994, with a government victory. In 1995 the country's Iraqi advisors were finally expelled and the US again began to supply aid, including spares for Yemen's surviving (11?) F-5Es and (two?) F-5Bs.



Westland Sea King Variant Briefing

A devastatingly effective anti-submarine helicopter, the Westland Sea King has been adapted to fulfil a wide variety of other roles from airborne early warning to air-sea rescue, all of which it performs with equal panache. Bloody in the Falklands War and acting as the mainstay of Royal Navy helicopter operations in the Gulf and over Bosnia, the Westland Sea King has proved rugged, reliable and highly effective. These virtues have not gone unnoticed, and the helicopter has been even more widely exported than the US design from which it was derived. An ongoing programme of development has kept the Sea King viable over the years, and will ensure that the type continues to fulfil a host of vital roles. Other Sikorsky S-3 derivatives will be covered in a forthcoming edition of *World Air Power Journal*.

Above: This Sea King HAS.Mk 6 of No. 820 Squadron Royal Navy is armed with a pair of Sting Ray torpedoes. The Mk 6 upgrade includes a replacement for the lightweight acoustic processing equipment (LAPADS).

Below: The Sea King is still the most capable Western anti-submarine helicopter, able to search for and acquire submarine targets by passive and active means and then deliver attacks on them without the help of ships.



Westland has reached its status as one of the world's busiest helicopter manufacturers by building a succession of designs which originated with other companies. The Dragonfly, Whirlwind and Wessex were licence-built versions of the Sikorsky S-51, S-55 and S-58, respectively, although they were refined and modified almost beyond recognition, at least from the cockpit. Externally, however, they remained very much 'other people's aeroplanes'. The stillborn Westminster, whose two prototypes bore little external resemblance to any Sikorsky aircraft, was based around S-56 dynamics. The Scout and Wasp had their origins in the Saunders-Roe P.531, while the Lynx, Puma and Gazelle were products of a collaborative Anglo-French agreement. Of these, the Lynx was effectively an indigenous Westland design. The Puma and Gazelle were essentially French designs built without modification. The Sioux was similarly unmodified, a Hayes-built Agusta-Bell AB 47G-3B-4.

To regard Westland merely as a licence-builder of other companies' designs is a gross distortion, however. Generally, Westland has taken good, sound airframes and rotor systems, and improved their powerplants, systems and avionics to produce far more capable variants than the original parent company. Westland's adoption of turbine power in the Whirlwind and Wessex transformed these aircraft, allowing them to remain in service long after their US equivalents had been retired. Westland's development of the basic S-61 has been similarly far-reaching and more were exported by the parent company than by Sikorsky itself.



Westland adapted the Sea King to fulfil a wide variety of roles, and kept development going long enough to produce examples that remain among the most advanced ASW aircraft in service worldwide. Of the Sea Kings remaining in front-line military service today, the bulk are Yeovil-built machines.

A licence-built version of the American Sikorsky S-61 (and even sharing the same name), Westland's Sea King is in many respects

The Royal Navy's Sea King HC.Mk 4s are among the best equipped transport helicopters in NATO, and future updates include a .50-calibre FN Herstal door gun with RING laser sight, fully NVG-compatible cockpit and Kevlar armour.

Qatari Commando Mk 3s are unusual in that they have a radar to acquire targets for their Exocet AM 39 missiles and Sea King-style undercarriage sponsons. Prominent intake filters are fitted to reduce sand ingestion.



Westland Sea King Variant Briefing



a new aircraft, with only the basic airframe and rotor system in common with its US progenitor. The US-built Sea Kings (and the licence-built Italian and Japanese versions) are treated separately.

In the USA, the use of pairs of HSS-1 (S-58) Seabats (one hunter, one killer) in the ASW role quickly showed the flaws of the separate two-aircraft hunter and killer concept, and Sikorsky began work on a new helicopter type

which could combine both roles into a single hunter/killer helicopter. In the UK, the RN had encountered similar limitations when operating pairs of Whirlwind HAS.Mk 7s, and the Bristol 191 (a navalised derivative of the Belvedere) was designed with this in mind. The big Bristol was cancelled in 1960. Westland had already embarked on an interim solution to the problem, producing the Wessex HAS.Mk 3, which simultaneously could lift ASW detection

The excellent camouflage used in Norway by Royal Navy commando squadrons is in contrast to the all-white scheme with UN insignia used in Bosnia. The HC.Mk 4 now has the AN/AAR 47 missile approach warning system.

equipment, crew and weapons, although this proved to be rather lacking in endurance. As the Soviet submarine threat developed, it became increasingly apparent that a longer-ranged ASW helicopter would be necessary. Both Westland



Left: The upgrade from Sea King HAS.Mk 5 to Mk 6 also included improving the ESM system to Orange Reaper standard, the fitting of improved tactical displays for the observer, installation of secure speech radios and internal MAD system.

Above: The Belgian air force operates six Sea King Mk 48s on search and rescue duties at Coxyde. These aircraft are currently being upgraded with a FLIR 2000F system and Bendix RDR 1500 radar, and will serve until around 2010.



Above: The Sea King HC.Mk 4 has proved extremely reliable in service. The relentless pace of operations in the type's history includes the Falklands War, operations in Kurdistan and Iraq in the Gulf War, relief flights in Bangladesh after that war, and Arctic warfare training in Norway.

Right: The Sea King Mk 4 of the Empire Test Pilots School carries a nose radar installation. Its red, white and blue colour scheme is similar to that worn by the two Mk 4Xs used by the Defence Research Agency.

and the Royal Navy had followed with great interest developments on the other side of the Atlantic, and no programme had been examined in more detail than the Sikorsky S-61 Sea King; this initially had been designated HSS-2 by the US Navy, then SH-3A under the tri-service designation system adopted in July 1962.

This helicopter had been designed to meet the same kind of broad requirement as was then being formulated by the Admiralty, and acquisition of the aircraft, or of a refined derivative, was an obvious solution when its 1956 order for 68 Bristol 191s was made irrelevant by the type's cancellation. Sikorsky fought hard to have its own SH-3D selected by the Royal Navy but, realising the political advantages of having the involvement of a British company that employed British workers, made an agreement with Westland to allow licence production should Westland's competing bid for an Anglicised, Yeovil-built Sea King beat Sikorsky's own offer.

Production contract

Westland's licence agreement with Sikorsky allowed the Yeovil-based company to use the basic S-61D (SH-3D) airframe and rotor head, but to make any necessary modifications to use alternative powerplants, systems and avionics. With its proven track record of extracting maximum potential from previous Sikorsky designs, and with the political advantages of minimising dollar expenditure and maximising UK employment, Westland won the competition. A £24 million production



contract (for 60 Sea Kings) was signed on 27 June 1966.

The basic S-61 followed the conventional Sikorsky 'Penny Farthing' configuration, with a single main rotor and a single anti-torque tail rotor. The five-bladed main rotor had light alloy blades, with an extruded leading edge and with 23 'pockets' bonded onto the trailing edge

of each spar. Inert gas was fed into the blades under pressure, and any escape of gas gave a cockpit warning indication, thereby warning of incipient failure. A larger aircraft than its predecessors, the S-61 had an unusual boat-like watertight hull, and incorporated outrigger-mounted sponsons acting as stabilising floats and also serving as fairings for the retractable



Pakistan's Mk 45 Sea Kings operate in the anti-submarine and anti-ship roles, armed with AM 39 Exocet. The type is flown by No. 111 Squadron at PNS Mehran. The Mk 45 is less potent than neighbouring India's Sea Eagle-armed Mk 42s.



This well-used Norwegian Sea King is one of the Mk 43s used by No. 330 Skvadron in the search and rescue role. These aircraft operate from Bodø, Banak, Ørland and Sola; all Norway's Sea Kings are to be upgraded to Mk 43B standard by 1996 and two new Mk 43Bs will be purchased.

Sikorsky and Westland Sea Kings, short of making a direct side-by-side system-by-system comparison. In any case, since even the Sikorsky Sea King variants varied from each other, it must first be ascertained with which H-3 one is comparing the Westland Sea King.

Gnome engines

The British Sea King was actually based on the SH-3D, the second major US Navy variant. This had been fitted with more powerful 1,400-shp (1050-kW) T58-GE-10 engines (in place of the 1,050- or 1,250-shp/787- or 937-kW T58-GE-6s of the SH-3A) necessitating an improved gearbox and structural improvements to cope with higher all-up weights.

Although the ability to accept British engines was a key feature of Westland's licence agreement, the powerplants used in the British Sea King were Rolls-Royce Gnomes, themselves licence-built derivatives of the T58 turboshaft which already powered the aircraft. These were, however, fitted with Hawker Siddeley/Rolls-Royce full-authority electronic engine control systems, which marked a considerable improvement over the electro-mechanical Hamilton-Standard control units used on American Sea Kings. Both T58 and Gnome were turboshafts with a 10-stage axial-flow compressor, an annular combustion chamber, a two-stage axial flow gas generator turbine and a three-stage power turbine. The Gnome H1400 turboshafts used by the initial British Sea Kings were rated at 1,250 shp continuous, with a one-hour maximum rating of 1,400 shp (1050 kW) and a 2.5 minute contingency rating of 1,500 shp (1125 kW). During production of the Sea King, the Gnome was to be upgraded several times, giving improved reliability and power output.

Lone hunter

Four pattern aircraft (actually S-61D-2s) purchased from Sikorsky and assembled in Britain were followed by production of the first Royal Navy service variant, the Sea King HAS.Mk 1. Although the SH-3D and Sea King HAS.Mk 1 carried the same number of crew, the duties carried out by the members of the crew differed somewhat. In the US Navy the ASW helicopter was regarded as being a remote sensor/weapons delivery platform for surface warships, which would control the aircraft from their own Combat Information Centers. In the US Navy SH-3 the first pilot also functioned as the tactical controller of the aircraft (insofar as one was needed), with the sonar operators in the cabin acting as low-status (often non-commissioned) equipment operators. In the Royal Navy the philosophy had moved towards using the helicopter as a more autonomous asset, capable of operating alone, and of

main undercarriage units. These sponsons also incorporated extra inflatable flotation bags, to give extra stability in anything more than mill-pond conditions. Although these features did give the S-61 a limited calm-water operating capability, the aircraft was never intended to be a 'helicopter flying-boat', nor even to be truly amphibious. All helicopters are inherently too top heavy for waterborne operations with anything more than the most moderate swell. The Sea King's floats and boat hull would, however, give a sporting chance of recovering the aircraft should it have to ditch in a calm sea (theoretically up to Sea State Three), and would in any case allow it to remain upright at least long enough for the crew to 'abandon ship'.

Unlike the S-55 and S-58, the Sea King was

designed with the flight deck and cabin at the same level, with a deliberate 'walk-through' environment. In the earlier types, with their high-mounted cockpits, it was virtually impossible to move between flight deck and cabin. This allowed much easier communications between the pilot and co-pilot up front and the two-man tactical crew in the cabin.

Sea King changes

In order to satisfy political expediencies, the Westland Sea King was officially classified as a 'minimum change' version of the SH-3, while many claimed that only the airframe and rotor head remained unchanged. Such directly conflicting statements make it difficult to assess the true extent of the changes between the



Pulling up for a wing-over, this Royal Australian Navy pilot proves that not all Sea King flying is hovering and 'pinging'. All the Australian Mk 50 Sea Kings are to be updated by Westland with airframe and avionics modifications by 1996.

Fitting a Sea King onto frigate-sized deck is not easy, and the Royal Navy operates the type only from its large vessels and (rarely) Type 22 frigates. The Sea King's replacement, the EH101, will operate from frigates despite being heavier.

controlling or operating with other assets. In the Sea King HAS.Mk 1, Westland followed the crew concept of the Wessex HAS.Mk 3, which had been the first Royal Navy helicopter optimised for autonomous operation. The first pilot (in the right-hand seat, as is traditional in the helicopter world) was not necessarily captain of the aircraft. Instead, the senior of the two crew in the cabin, the observer, was the anti-submarine officer and tactical co-ordinator, commanding not only the aircraft but also other assets being used in a search and attack operation, perhaps including surface ships commanded by officers of much higher rank. This difference in operating philosophy led to a very different interior arrangement in the Westland-built Sea Kings, with an automatic tactical plotting display in the observer's position combining radar and sonar information.

Tactical systems

North-orientated, and able to show the helicopter centrally or with a specific point at centre, the display took inputs from the Marconi AD580 Doppler (the SH-3D used Ryan AP-130 Doppler) and from the Plessey 195 sonar (compared with Bendix AQS-13 in the SH-3D). Most importantly, the British Sea King carried its own search radar, while US Navy SH-3Ds relied on radars on board co-operating ships. The Ecko AW391 (later known as the MEL Lightweight) search radar antenna was located in a dorsal 'thimble' radome aft of the main rotor, providing an immediate recognition feature. This radar was very useful for surface search, and could detect submarine snorts and periscopes in most sea states.

The effective use of dipping sonar demands

Right: Among the very last Sea Kings to be produced (unless another order is soon forthcoming), these Norwegian Mk 43Bs have nose radar and a FLIR system mounted on the port side of the chin, similar to Belgian Mk 48s.

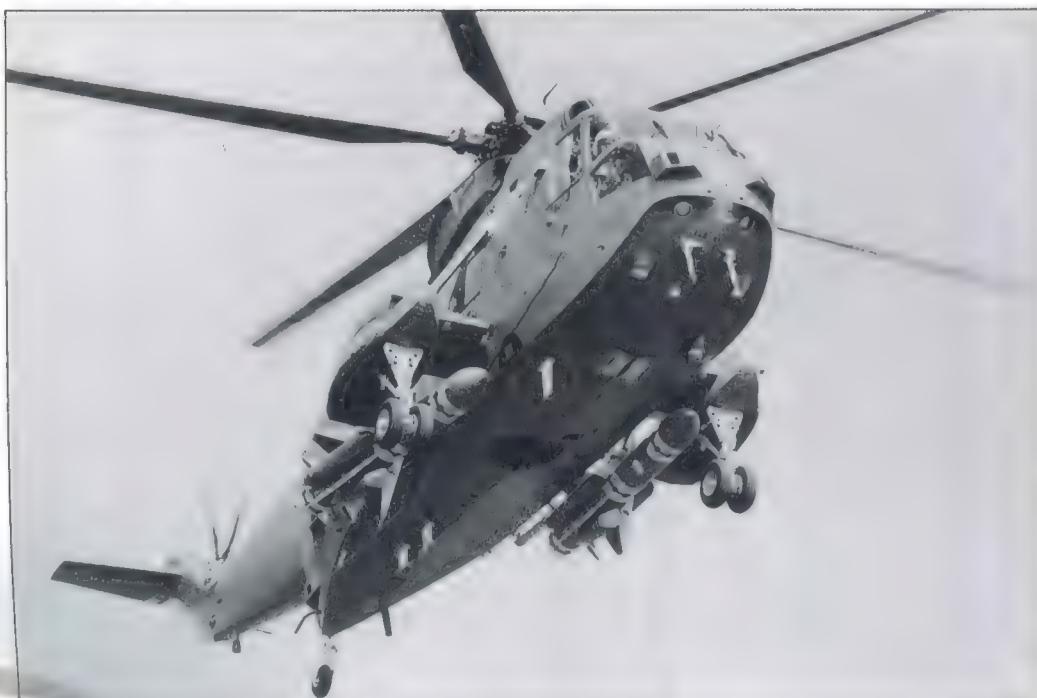


Left: Similar to the HAS.Mk 5, the HAR.Mk 5 differs in having no acoustic processing or tactical systems in the rear compartment and no observers. An aircrewman and occasionally a SAR diver are carried for rescue duties.



extremely accurate hovering to maintain position and to maintain the vertical attitude of the sonar cable. Because helicopters are inherently unstable, maintaining an accurate hover is extremely difficult, requiring constant pilot input. In Britain, this problem was addressed by the Louis Newmark company, who developed a sophisticated automatic flight control system which used inputs from the Doppler and radar altimeter to take the helicopter into a stable hover at 40 ft (12 m). This is the optimum height for dipping sonar, keeping the helicopter clear of wave crests and the worst of the spray. Westland's Sea King HAS.Mk 1's Louis Newmark Mk 31 system reverted to being single channel (Simplex) whereas the Mk 30 system of the Wessex HAS.Mk 3 was Duplex (two channels). Experience had shown that a Simplex system

Westland Sea King Variant Briefing



Above: Egypt operates Commando Mk 1 and Mk 2s in the assault transport role, and the rarely seen Mk 2E electronic countermeasures variant. Egypt also operates five HAS.Mk 47s in the anti-submarine role, which will soon be supplemented by Kaman SH-2G Seasprites.

Left: Another Egyptian Sea King variant is the Commando Mk 2B, two of which serve in the VIP transport role. These aircraft are recognizable by their distinct colour scheme and large cabin windows. Qatar also operates VIP Commandos, two Mk 2As serving with No.9 Squadron.

would be reliable enough, while being much lighter and cheaper.

While the HAS.Mk 1 retained the 600-lb (272-kg) capacity rescue hoist and 6,000-lb (2720-kg) capacity rescue winch, Westland added an auxiliary hover trim lever in the cabin door, allowing the winch operator to control the aircraft laterally in the hover, at speeds of up to 10 kt (18 km/h; 11 mph). This is particularly useful in the search and rescue role, in that it allows the aircraft to hover accurately over an object in the water, for example a survivor.

British differences

British-specified communications equipment replaced the US radios of the SH-3D with Bendix RT221 VHF (and Pye Westminster VHF(FM) for marine band SAR comms), Plessey ARC-52 UHF (with UHF homing), Ultra D403M Stand-by UHF, and Collins 618T HF for ultra-long range communications. MEL IFF transponders were also fitted. The Sea King HAS.Mk 1 could carry many of the same weapons as its US Navy equivalent, but was also compatible with a range of British weapons, including WE177 nuclear depth bombs.

Although primarily acquired for use in the ASW role, the Royal Navy had always

India's Mk 42B Sea Kings, which are equipped virtually to British HAS.Mk 5 standard, are among the most advanced of any in service. The square profile radar fairing houses Sea Searcher radar and the aircraft are armed with the 100-km range Sea Eagle sea-skimming cruise missile.



The HAS.Mk 5 performed many other missions for the Royal Navy than simply hunting submarines. SAR and vertrep were common sorties, and during the Falklands war the aircraft were even used as makeshift troop carriers.

envisioned the Sea King carrying out a variety of secondary roles, including search and rescue, the carriage of underslung loads, photography and even rapid conversion for troop carrying. So successfully did the Sea King carry out these roles that Westland designed and produced a succession of new variants, optimised for various roles and customers. It even resulted in the emergence of a quite separate family of dedicated troop carriers, the HC.Mk 4 for the RN, and the export Commandos, echoing the division of Wessexes into anti-submarine 'Pingers' and commando-carrying 'Junglies'.

Even before the Sea King HAS.Mk 1 began to enter service, the Royal Navy was

The Sea King has a load-carrying capacity of 7,936 lb (3600 kg) using its hoist, or a capacity of about 28 survivors in the rescue role. RAF HAR.Mk 3s are purpose-built, but the Royal Navy's HAR.Mk 5s are converted HAS.Mk 5s.

Above: Serving in the assault transport role, the six Indian Navy Sea King Mk 42Cs serve with INAS 339 at Margar. The Indian Navy also uses the Sea King in the ASW role, with Mk 42As and Mk 42Bs based at Dabolim with INS 330 and 20 Mk 42Bs based at Cochin with INS 336.

undergoing profound changes. The writing was already on the wall for the fixed-wing carriers, and indeed for the entire power-projection role 'East of Suez'. The possibility of Harrier-carriers was still uncertain, and the Sea King seemed to represent the future of naval aviation in Britain, lending the programme greater importance. Development of the Sea King was therefore accorded a high priority, and development of a second-generation ASW Sea King (to become the HAS.Mk 5) began during the mid-1970s. The commitment to developing and improving the Sea King for the Royal Navy kept the aircraft 'at the cutting edge', and this made it a particularly attractive option for export





The all-grey Sea King HAR.Mk 3s of No. 78 Squadron are used for search and rescue duties from RAF Mount Pleasant in the Falkland Islands. This squadron's aircraft are equipped with chaff and flare dispensers and RWRs.

Kings, including the Commando Mk.3 and the Sea King Mks 42B and 42C. There are, of course, other ways of classifying Sea King sub-variants. One such method is by airframe, although this is not always satisfactory. The Commando, for example, usually lacks flotation sponsons and rotor blade and tail folding, although RN HC.Mk 4s retain folding, and Qatari Commando Mk 3s have sponsons and spine-mounted radomes. Rescue versions usually have the lengthened cabin which results from moving the rear bulkhead aft by 5 ft 8 in (1.7 m), and which is usually indicated externally by the provision of an extra pair of bubble observation windows.

Export success

Under the terms of its original licence Westland was allowed to sell Sea Kings to 'Western-friendly' countries outside the USA on a non-exclusive basis, meaning that wherever it sold a Sea King, Westland would have to compete with Sikorsky and the other licensees. Throughout its production the Westland-built aircraft was always considerably more advanced than the basic Sikorsky H-3, and proved sufficiently attractive to appeal to eight overseas customers. The Sea King became a very big earner for Westland, seeing the company through what might otherwise have been lean times. Manufacture continued long after the Gazelle and Puma production had ceased, and necessitated enlargement of the erection shop and construction of a new air traffic control tower.

The Sea King's primary military duty in Royal Navy service was in 'holding the line' in ASW operations during the Cold War, an unsung and thankless but nevertheless vital task. Had the Cold War ever turned hot, Royal Navy Sea Kings would have operated from ships and shore bases in a frantic and desperate battle to prevent Soviet submarines from breaking out into the Atlantic, and in keeping

customers. Sea King improvements were built around the introduction of more powerful engines and uprated transmission, which gave enhanced performance and increased payload. To these 'core improvements' were added new avionics and mission systems, which later, in the so-called 'Advanced Sea King' incorporated greater use of composite materials, including Westland-designed advanced composite rotor blades.

The Westland-built Sea King family can be loosely divided into three generations according to their powerplants. The first generation (HAS.Mk 1, Commando Mk 1, Mk 41, Mk 42, Mk 43 and Mk 45) were powered by the basic Gnome H1400, and the second generation (the bulk of the aircraft delivered) by the H1400-1. The third generation are the Advanced Sea

The first Sea King (G-ATYU/XV 370) was merely a navalised Sikorsky SH-3D. The next three aircraft (XV 371-373) were used in trials work for the Royal Navy specified anti-submarine systems, and delivery of production standard HAS.Mk 1s to the Royal Navy began in May 1969.



NATO's vital ports, submarine bases and transatlantic sealanes safe. The aircraft has also played a more obvious and glamorous role in several less vital if more visible wars and conflicts.

The first and perhaps the most visible of these was Operation Corporate, Britain's successful 1982 effort to retake the Falkland Islands after an Argentine invasion. More than 60 Sea Kings (of various types) were sent south with the task force, operating in the ASW, combat SAR, transport, Special Forces insertion, casevac and vertrep roles. The fleet amassed 11,922 flying hours in 5,552 sorties, and clocked up 8,613 deck landings. Despite the primitive conditions and foul weather, the Sea Kings had an availability rate in excess of 90 per cent.

Corporate losses

Operations cost three HC.Mk 4s (one burned by its crew after landing in Chile, two lost in accidents), two Mk 5s lost in accidents, and a Mk 2 lost after ditching following an engine failure. At least one aircraft would have been recovered in peacetime, and had to be sunk by naval gunfire because it was felt to be too dangerous to allow a warship to stop and hoist the helicopter aboard.

ASW Sea Kings were deployed aboard HMS *Hermes* (No. 826 Squadron), HMS *Invincible* and RFA *Fort Austin* (No. 820 Squadron), and RFA *Fort Grange* and *Olmeda* (No. 824 Squadron). Nos 820 and 826 Squadrons were equipped with Sea King HAS.Mk 5s and these bore the brunt of screening the task force. No. 824 Squadron used HAS.Mk 2As that performed similar tasks, before deploying to South Georgia for Operation Keyhole. The ASW Sea Kings acted as a powerful deterrent, and no enemy submarine penetrated their defensive screen. Weapons were used against a handful of contacts, but these, unfortunately, turned out to be whales.

Converted troop carriers

In the transport role, the specially-formed No. 825 Squadron deployed with Sea King HAS.Mk 2As gathered from various sources and stripped of their ASW equipment, which gave them the ability to carry between 16 and 24 troops, depending on range. The unit was manned by volunteers. Like the dedicated transport Sea Kings deployed for Operation Corporate, the ASW aircraft spent much of their time moving troops, ammunition, and supplies from ship-to-ship and from ship-to-shore, gaining the nickname 'Pinglie' in the process. The dedicated No. 846 Squadron deployed with their Sea King HC.Mk 4s. It was No. 825 Squadron's aircraft which were involved in the recovery of casualties from the RFA *Sir Galahad* and RFA *Sir Tristram*, daringly using rotor downwash to blow liferafts away from the burning ships and hovering in thick smoke to pick up survivors. Sea Kings of various types were used as decoys to divert inbound Exocet missiles using chaff; Prince Andrew, the Queen's second son, was involved in flying these missions with No. 820 Squadron. This



Known as 'bags' to their crews, No. 849 Squadron's Sea King AEW.Mk 2s give the Royal Navy a vital airborne early warning capability, which will be enhanced by software and hardware improvements. The squadron is the only UK helicopter unit to routinely fly with parachutes during operations.



Although based on an elderly airframe, the Commando can carry twice as many passengers as a UH-60, although it lacks the speed and lifting power of the newer machine. The Commando is a rare example of a good assault helicopter derived from an anti-submarine airframe and not vice versa.



Qatar operates only three Commando Mk 2As. The original order for the type was much larger, but this was cancelled and these machines were then acquired by the Royal Navy as the first batch of HC.Mk 4s to replace the Wessex.



This Marineflieger Sea King Mk 41 is escorted by a Westland Widgeon, a civil version of the Sikorsky Dragonfly (used as a company 'hack'). The Sea King has been a great export success for Westland but only two Widgeons were built.

was reportedly the first time a Royal Prince had been engaged in actual operations since the 'Black Prince' (Edward, Prince of Wales, 1330-76).

The Falklands conflict provided proof of the Sea King's robustness and maintainability. One No. 825 Squadron's aircraft flew for seven hours with a punctured main rotor blade, and another aircraft had its holed fuel tank mended with a standard car tyre repair outfit. One No. 846 Squadron HC.Mk 4 wrote off its tail rotor pylon when it landed hard after coming under fire, but was returned to flying condition, in the open, by fitting the tail rotor pylon from a

The Sea King has proved to be surprisingly reliable in service, and has demonstrated its ability to keep going in the freezing conditions of Norway and the equally severe climate of Kurdistan, as well as in conditions at sea.

damaged No. 825 Squadron HAS.Mk 2A, using muscle-power and crates alone, with no stands, ladders, hoists or pulleys. The rebuilt aircraft took part in support of the final 'Yomp'.

Granby deployment

Eight years later, the Royal Navy's Sea Kings and Commandos found themselves at war again during Operation Granby, Britain's part of the multinational campaign to eject Iraqi forces from Kuwait. The Sea Kings performed ASW, mine-hunting, transport, casevac, Special Forces insertion, and vertrep missions. The Royal Navy's aviation training ship, the RFA Argus, was deployed to the Gulf to act as a Primary Casualty Receiving Ship (a hospital ship in all but name, avoiding the attendant strictures of the Geneva Convention, which lays down that anyone admitted to a Hospital Ship can only be

returned to his unit via a neutral country). Sea King HC.Mk 4s served aboard the Argus and the RFA Fort Grange, and from land bases in support of the 1st (British) Armoured Division. The helicopters used new equipment including NAVSTAR GPS and a new tactical air navigation system, the Racal RNS-252 'Supertans'. No. 826 Squadron's Sea King HAS.Mk 5s were specially modified for the mine-hunting role, and flew with crews which included a diving supervisor and three divers.

Grapple and Haven

Following the success of Operation Desert Storm, Royal Navy Commandos participated in relief operations in Turkey and northern Iraq under the auspices of Operation Haven, and more recently have taken part in operations over Bosnia as part of Operation Grapple. Operating from Split in Croatia, Sea King HC.Mk 4s operated in UN white overall, with prominent UN markings and an RN ensign. The aircraft were fitted with a comprehensive defensive suite that included MAWS, chaff/flare dispensers, RWRs, UHF/VHF secure voice radios, Mode 4 IFF, GPS-TANS-2 and 7.62-mm GPMG door guns. The aircraft flew with Arctic 'Pulk' survival packs, and the aircrew wore Kevlar body armour and carried L1A1 (SA80) rifles or 9-mm Browning pistols.

Participation in such operations has frequently led directly to important modifications or the incorporation of new



Westland Sea King Variant Briefing



The Sea King's success can be measured in many ways, not least its longevity. When the Royal Navy's Sea King HC.Mk 4s are retired, which is expected to be around 2008, the aircraft will be almost 30 years old. These helicopters have been among the most active aircraft in NATO.

systems or weapons, which would often take years in peacetime, even if they were funded. Perhaps the most impressive example of a war-generated modification programme was provided by the design and production of the Sea King AEW.Mk 2A, which was produced in only 11 weeks from design to deployment of the two prototype conversions. Less tangibly, such actions have provided invaluable operational experience for Sea King air and ground crew, allowing them to assess and analyse the value of their peacetime training, and to refine procedures in the light of such experience.

Today the Sea King remains an important type even in the UK. In the Royal Navy the type equips one AEW squadron, one SAR



The German Sea King Mk 41 is operated by the Marinefleiger, with 1/MFG 5 at Keil/Holtenau in the anti-surface and search and rescue roles. For the anti-surface role the Marinefleiger Sea Kings use the BAe Sea Skua missile in conjunction with the Sea Spray radar, which was installed after 1986.

squadron, five ASW squadrons and three HC.Mk 4 commando squadrons. In Royal Air Force service the Sea King equips two full-strength SAR units, and one flight of No. 78 Squadron in the Falklands. Deliveries of the Sea King HAS.Mk 6 continue, but the aircraft's replacement in the ASW role, the Anglo-Italian EH101, is already well advanced and into its flight test programme; the Royal Navy version will be named Merlin HAS.Mk 1 and 44 aircraft are on order. This seems a very small number to replace even the five-squadron force of ASW Sea Kings, and some Sea King HAS.Mk 6s may be expected to remain in use, augmenting the Merlin, for many years, despite the reduced submarine threat. Sea Kings are

also likely to remain in use in the SAR and commando roles for some time. With the EH101 Merlin on the verge of full-scale production, ironically just when the submarine threat has diminished, it seems unlikely that significant numbers of new Sea Kings will be built at Westland, although modifications and rebuilds will continue to keep Yeovil's highly skilled workforce busy for many years to come.

Jon Lake

Almost certainly the last Sea Kings to be built are a batch of HAR.Mk 3As for the Royal Air Force and two Mk 43Bs for the Royal Norwegian air force. The Sea King must be ranked as probably the most successful naval helicopter of all time, with many years of service remaining.

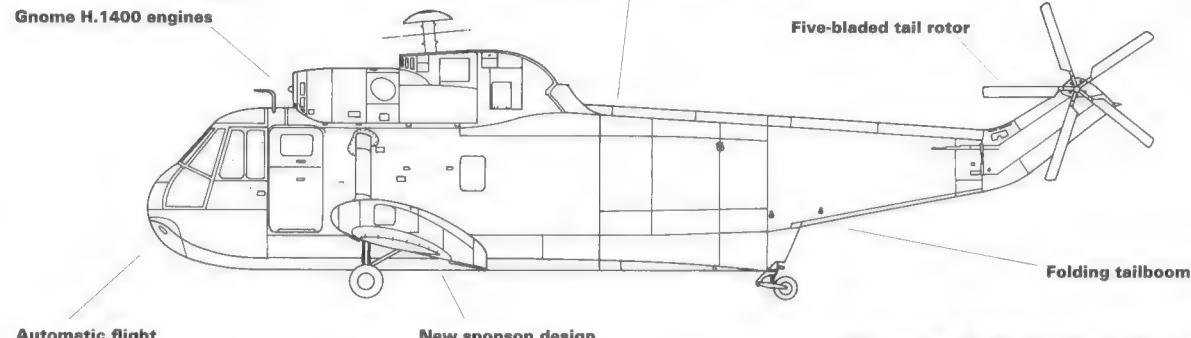


Sea King Variants

Sikorsky S-61D-2 Sea King

Four S-61D-2s (SH-3Ds) were supplied by Sikorsky to serve as pattern and trials aircraft for the Westland Sea King production programme. The first of the quartet was cocooned and shipped to Avonmouth as deck cargo, where it was prepared for flight on the dockside by Sikorsky and Westland engineers. It was flown to Yeovil on 8 September by Westland's then-Chief Test Pilot 'Slim' Sear. It was used for performance testing, handling and AFCS work. Ten years after the first flight of the original Sikorsky SH-3, the final three prototypes were delivered in kit form. The second aircraft was used for handling and AFCS trials. The third aircraft was allocated for engine performance trials with the Gnome but crashed on 15 January 1969 following an unsuccessful autorotation, after ice ingestion caused an engine to flame out. The hulk of this aircraft was later used for various ground-based trials by Westland. The fourth aircraft was used for systems and avionics development, including the Plessey sonar and Ecko AW391 radar. All four prototypes were converted to Westland Sea King standard, with British engines, avionics and systems. Even the bag-type fuel tanks were of British manufacture. The double-section forward cell contained 287.3 Imp gal (1306 litres), the centre cell 120.7 Imp gal (549 litres), and the double-section aft cell 239.9 Imp gal (1090 litres), with cross feeds between all the cells.

XV370 retired in 1989, having spent its last years in service with the Empire Test Pilot's School, wearing a smart red, white and blue colour scheme similar to the DRA's Mk 4X Sea Kings. XV373 had already retired, in 1986, having finished up as a navigation and radio trials aircraft. One of the four pattern aircraft, XV371, remained active with the DRA fleet at Boscombe Down during 1995. This aircraft has performed a variety of tasks and trials, one



Sikorsky S-61D-2 Sea King

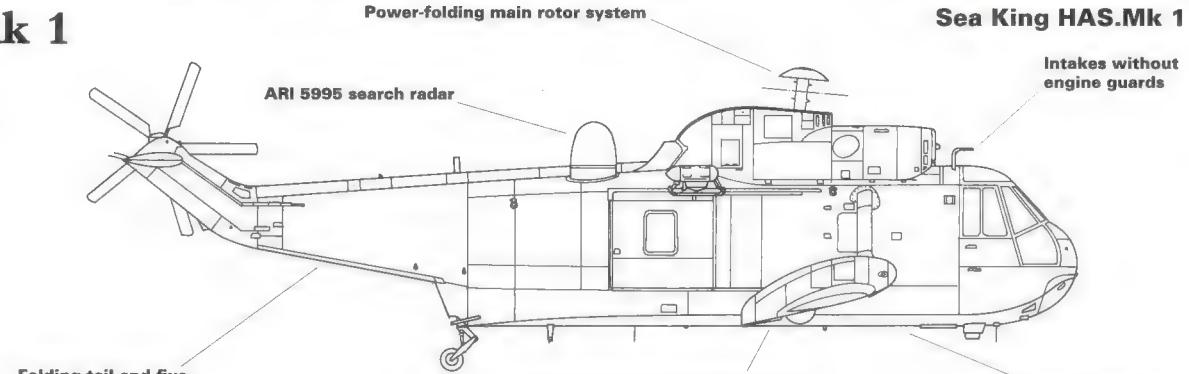
of the most recent being REDOWL (Remote Eyes in the Dark Operating Without Light) which used a helmet-steered LLLTV (Low-Light-Level Television) camera to give the pilot a picture of the outside world, displayed to him in real time on a helmet-mounted display. Sensor line of sight directly follows pilot head movements, allowing him to look around as he does when flying the helicopter in daylight. Although the pilot only sees a 40° slice of the real world at a time, from its position on the tip of the nose the sensor can 'look' through 100° on each side of the centreline, and from 20° up to -100° down (actually allowing the pilot to see directly down 'through' the cockpit floor!). A similar system known as Virtual Panoramic Display is currently under test with the US Army.

The prototype Sea King was a converted S-61D-2 fitted with British engines and mission equipment, which proved the concept of a greatly improved SH-3 derivative.



Sea King HAS.Mk 1

A production order for 56 production aircraft was placed on 27 June 1966. The first prototype, XV642, made its maiden flight on 7 May 1969, joining the four Sikorsky-built pattern aircraft. Trials and tests went extremely smoothly and few delays were encountered. XV645 was delivered to Culdrose on 11 August 1969 for service trials. Operational trials concluded with a record-breaking non-stop unrefuelled flight by XV587 from Lands End to John O'Groats. The aircraft was fitted with a 1,500-lb (680-kg) overload tank, giving a total of 6,800 lb (3045 kg). Serialised between XV642 and XV677, and XV695 and XV714, the 56 HAS.Mk 1s were fitted with Ecko AW391 search radar (also known as the MEL ARI.5995 or MEL lightweight) with a prominent dorsal thimble radome. Most of the avionics were housed in the bottom of the nose, with the navigation system black boxes on a pull-out tray. The aircraft had Marconi AD580 Doppler and bathythermographic facilities for measuring



temperature gradient in the water to allow more accurate interpretation of sonics data. They also featured a Plessey 195 dipping sonar and an ARC-52 UHF homer. Communications equipment included

Collins 618T series HF SSB, Ultra (Dowty) D403M Standby UHF, Bendix RT221 VHF and Pye Westminster for SAR-dedicated aircraft. The introduction of radar, AFCS and electronic engine controls made even this, the baseline Westland Sea King, a significant improvement over the original US-built SH-3D from which it was derived, although the key elements of the system were identical to those fitted to the Wessex HAS.Mk 3. It was the first Royal Navy helicopter with a retractable undercarriage, the first with a boat hull and the first to incorporate power-folding and spreading of the fully-articulated main rotor. This was actuated by the secondary hydraulic system with interlocks to prevent a mis-sequence.

The Sea King HAS.Mk 1 was fitted with fully duplicated dual controls, with two independent hydraulic systems actuating each channel. Three primary servos are connected to the non-rotating swash-plate, which transmits movement directly to the rotating swash-plate and via push-rods to

the rotor head. One servo operated pitch control, and two operated roll control acting together for collective pitch control, or separately for cyclic pitch control. Another servo actuated the tail rotor collective pitch control. The Louis Newmark AFCS incorporated a pre-programmed transition manoeuvre, allowing a fully automatic transition to and from the hover, with a very wide entry gate, allowing the aircraft to enter the hover from a wide range of heights and speeds. The aircraft's twin engines made for considerably greater safety in the ASW role. Twin-engined safety is of obvious benefit in overwater operations, but is doubly necessary for dunking sonar, when much of every sortie is spent below the minimum height at which an autorotation can safely be carried out. Armament consisted of four Mk 44 homing torpedoes, four Mk 11 depth charges, or a single nuclear depth bomb. The torpedo was then regarded as being the primary ASW weapon, except for shallow water operations, where depth charges were preferred. The chief recognition features of the original Sea King HAS.Mk 1 were its five-bladed tail rotor (with symmetrical section metal blades, unlike the latest five-bladed unit) and its lack of an intake guard.

The different crewing concept of the



Lack of large vessels suitable for the new Sea King forced the Royal Navy to convert cruisers such as HMS Tiger to carry them, which was not a successful combination.

Royal Navy's Sea Kings has been referred to already, but is worth reiterating because it resulted in a very different cabin arrangement internally. The sonar winch 'pit-head gear' mounted the observer's and operator's stations on its rear edge. The two crewmen faced forward, with the observer to port, and the sonar operator to starboard. Even with the sonar equipment left in place, the Sea King HAS.Mk 1 could carry 11 fully equipped troops, the number rising to 20 without sonar and 27 with the cabin stripped out. A 600-lb (272-kg) capacity variable-speed rescue hoist could be installed above the cabin door, and up to 6,000 lb (2720 kg) could be carried underslung.

The Sea King HAS.Mk 1 equipped No. 700 Squadron 'S' Flight, the Sea King IFTU, and Nos 707 and 737 Squadrons in

the training role and Nos 814, 819, 820, 824, and 826 Squadrons. Most surviving HAS.Mk 1s were converted to HAS.Mk 2 standards (exceptions were XV642, 644, 645, 646, 651, 662, 667, 669, 695, 702 and 704). All HAS.Mk 1s had disappeared from RN service by the end of 1980. One source suggests that the designation HAS.Mk 2 applies to conversions undertaken by Westland, and HAS.Mk 2A to conversions

undertaken at RNAY Fleetlands. The exact number of conversions remains a matter for dispute. One aircraft (XV651) was converted to serve as a trials aircraft for the Lynx's nose-mounted Sea Spray radar, subsequently becoming the only HAS.Mk 1 to be converted directly to HAS.Mk 5 standards. XV642 was used as a development aircraft by Westland to a standard similar to the HAS.Mk 2.

Sea King HAS.Mk 2

The Sea King HAS.Mk 2 came about as a direct result of improvements designed for the Australian Mk 50, whose prototype flew on 30 June 1974. The Royal Navy's HAS.Mk 2 used the same uprated 1,600-shp (1200-kW) Gnome H1400-1 engines and had the same gearbox improvements to cope with the increased power. The adoption of the more powerful Sea King resulted from a tentative retreat from the stated policy of withdrawing from East of Suez, necessitating a Sea King with better 'hot-and-high' performance. The new variant also had the new six-bladed tail rotor which improved yaw authority at high all-up weights. Most references state that the Sea King HAS.Mk 2 was characterised by the fitting of a prominent 'barn door' intake guard but, in fact, many HAS.Mk 2s initially flew without these. The guard was designed to deflect chunks of ice away from the engine intakes and soon incorporated TKS fluid de-icing strips in a chevron-shaped pattern on the face.

Only 21 Sea King HAS.Mk 2s were built by Westland, the rest being produced by conversion of the HAS.Mk 1 as detailed above. The first HAS.Mk 2 (XZ570) made its maiden flight on 18 June 1976 and No. 706 Squadron re-equipped with the new version in December 1976. Front-line squadrons equipped with the HAS.Mk 2 were Nos 814 and 819 at Prestwick and Nos 820, 824, 825 and 826 at Culdrose.

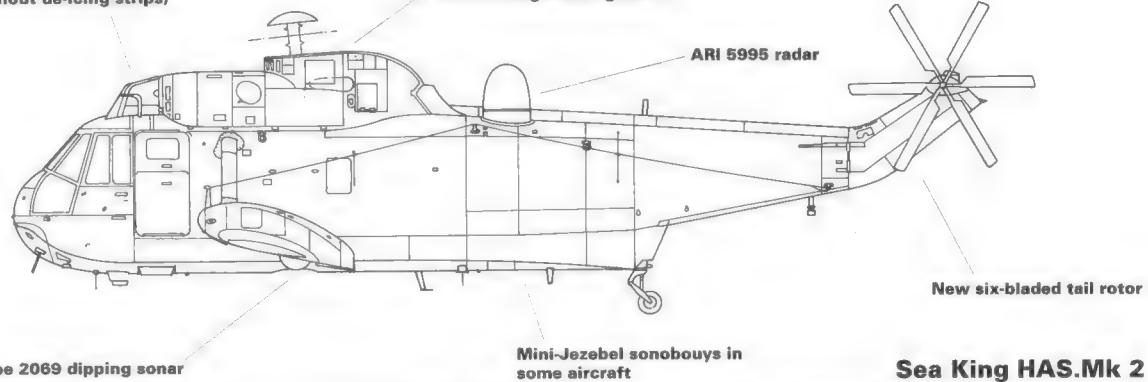
The avionics fit of the HAS.Mk 2 included Plessey Type 2069 Sonar, Racal Decca 71 Doppler, TANS, 80437A VOR/LOC receiver and 80442A DME interrogator, and a Honeywell AN/APN-171 radar altimeter. Communications equipment includes AN/ARC-52 UHF radio, Dowty D403M standby UHF, Dowty UA60 intercom, a Plessey PTR446A IFF/SSR transponder (a Cossor IFF 2720 transponder in the HAS.Mk 2A) and an MEL ARI.5954 I-band transponder.

There is some confusion as to the Sea King HAS.Mk 2A designation, some sources suggesting that it was applied only to those

aircraft converted to HAS.Mk 2 configuration by the RNAY at Fleetlands. Others suggested that the HAS.Mk 2A designation was applied after installation of the 'barn door' intake guard, or to the aircraft which had their ASW equipment removed for service with No. 825 Squadron in the Falklands, or to aircraft modified with refined avionics. There were several avionics upgrades and modifications, and most were fleet-wide. One programme which was confined to a handful of aircraft was the installation of Dowty SSQ904 Mini-Jezebel passive sonobuoys in No. 814 Squadron's HAS.Mk 2s. Some have even suggested that the designation applied to aircraft with the HAS.Mk 5-style fuel jettison pipe on the starboard side of the rear part of the hull, adjacent to the tailwheel. Westland has suggested that the designation was an unofficial one.

No HAS.Mk 2s remain in their original configuration, except as ground instructional airframes, all having been converted to HAS.Mk 5 or AEW.Mk 2A standards. Nine aircraft were converted to AEW.Mk 2

Intake guards (initially fitted without de-icing strips)



Sea King HAS.Mk 2

configuration, one to HAS.Mk 2 (Mod), and 54 (35 of these described as HAS.Mk 2As) to HAS.Mk 5. The majority of those converted to HAS.Mk 5 standards subsequently became HAS.Mk 6s.

The HAS.Mk 2's dipping sonar was found to be very effective in deterring submarines, but the preference for passive sonar tactics became more marked in service.

Sea King AEW.Mk 2A

The retirement of the Royal Navy's fixed-wing carriers (last of these being the HMS *Ark Royal*) left the fleet without organic airborne early warning cover. The threat of war in the South Atlantic posed by the Argentine invasion of the Falklands signposted the disadvantages of relying on the RAF's land-based Shackletons and radar picket ships, and after the loss of HMS *Sheffield* (acting as a radar picket) on 4 May 1982, a crash programme was instituted to provide the fleet with its own AEW platform. This was a tripartite effort by the Royal Navy, Westland and Thorn/EMI known as Project LAST (Low Altitude Surveillance Task), which resulted in flying hardware within only 11 weeks. At the heart of the programme lay the I-band Thorn EMI ARI 5980/3 Searchwater radar, a pulse-compression, frequency-agile search radar.

The AEW Sea King was produced by conversion of Sea King HAS.Mk 1s and HAS.Mk 2s, with a new Searchwater maritime surveillance radar. This was the same radar as was used in the RAF's maritime reconnaissance Nimrods, and had a proven ability to detect low-flying targets in any sea state, and with severe weather clutter, although it had been optimised for the detection of surface targets (such as submarine periscopes) and not fast-moving airborne targets. At 10,000 ft (3048 m) the radar has a range of about 125 miles (200 km) against a fighter-sized target. Multiple Track-while-Scan capability allows

continuous target tracking without interrupting the radar's search pattern, although this capability is little used. As soon as a contact is made, it is handed off to fighters or surface-to-air weapons controllers. Digital control of the radar gives very high performance while keeping operator workload low. The computer automatically controls PRF, beamwidth and antenna tilt once range has been selected, and if only a particular sector is of interest will automatically decide whether to rotate the antenna fully or to scan back and forth across the narrow arc. The radar produces a constant synthetic display rather than using a long-duration phosphor. The set is of modular construction, with comprehensive use of LRUs and built-in test equipment.

The antenna for the search radar is pitch and roll stabilised and offers a full 360° scan. It is housed in an unusual inflatable domed 'kettle drum' radome made of impregnated Kevlar fabric, which can be swung down to the vertical position in flight to project below the aircraft, and which can swing back to the horizontal to give sufficient ground/deck clearance to allow the aircraft to land. During early trials, a hole was dug in the airfield at Culdrose just large enough to accept a deployed Searchwater radome, in case an aircraft returned unable to retract its radar. This did not have to be used. The radome was 6 ft (1.8 m) in diameter. The installation was a masterpiece of improvisation, with the

swivel being adapted from a standard Sea King undercarriage actuator, and with the swivel arm carrying the radar being made from 12-in (30-cm) diameter steel pipe bought directly from British Gas. The Nimrod's ram air cooling system was not suitable for a slow-flying helicopter, and a new system had to be designed for the Sea King Searchwater installation.

The radar antenna is bulky, and does cause some drag, and cruising speed with the radar deployed is limited to 90 kt (166 km/h; 103 mph). Weight is less of a problem, since the scanner is made of plastic, with carbon-fibre. The original radar was retained for tactical and navigation purposes, but sonar was removed. The aircraft incorporated Racal MIR-2 'Orange Crop' ESM, which was standard on the HAS.Mk 5 then in front-line service. The AEW.Mk 2A also had a new Cossor IFF 3570 interrogator and a Ferranti FIN 1110

two-gimbal INS, but was otherwise similarly equipped to the ASW HAS.Mk 2.

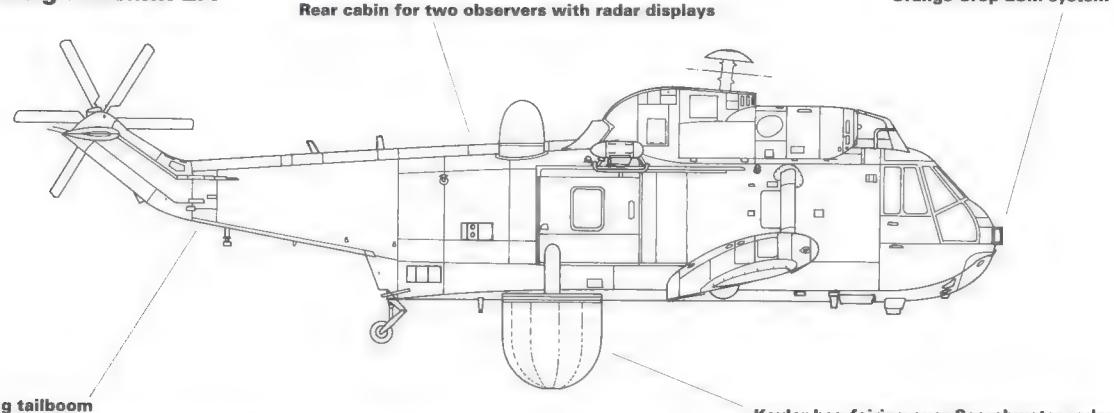
The success of the project was such that neither of the initial two conversions (XV650 and XV704) appeared at the 1982 Farnborough SBAC show. Both were deployed to the South Atlantic in the immediate aftermath of the Falklands War, a period of some uncertainty in which further Argentine air attacks could not be discounted, despite the official surrender of forces on the islands on 14 June. In fact, the first of the AEW.Mk 2As made its maiden flight on 23 July 1982. The two prototypes undertook flying trials aboard HMS *Illustrious* as part of No. 824

The result of an urgent requirement for a shipboard AEW platform, the Sea King AEW.Mk 2 has been highly successful in NATO exercises.



Sea King Variants

Sea King AEW.Mk 2A



Folding tailboom

Squadron, and from 27 August provided AEW cover for ships operating within the Falklands 200-mile (320-km) radius total exclusion zone.

No. 849 Squadron (previously the Fleet's AEW specialists, with AEW Gannets and

Skyraiders) reformed on 9 November 1984, and the two prototype conversions were joined by seven more AEW.Mk 2As (XV649, XV656, XV671, XV672, XV697, XV707, XV714). One of the aircraft (XV704) was subsequently deconverted and returned to

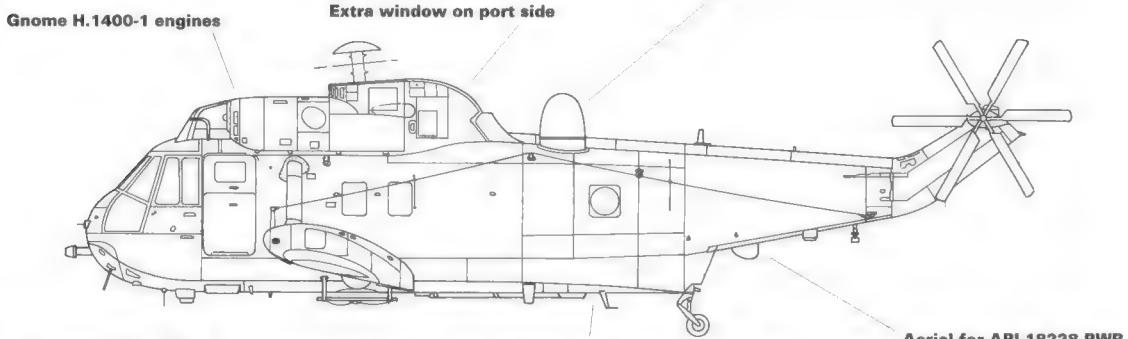
ASW configuration.

The AEW Sea King routinely operates with a crew of three, consisting of a single pilot (who must have two full tours in other Sea King variants) and two commissioned observers. One of the observers occupies

the co-pilot's seat during take-offs, landings and low-level operations, and would operate the manual throttles in the event of an emergency. The radar is located behind the observer's positions, in line with the radome swivel. The observers have two displays able to show a PPI (Plan Position Indicator) picture that is north-orientated and ground-stabilised by Doppler, or a selected enlargement, or an A-scope display showing the shape of the radar contact and its length. The fidelity of this type of display is often sufficient to allow accurate ship recognition.

A modest upgrade to the AEW.Mk 2, with a new Mk XII IFF interrogator, Link 16 JTIDS, an extra secure voice Have Quick II radio and modernisation of the Searchwater radar to incorporate a pulse-Doppler capability, seems to have been overtaken by a more ambitious upgrade, described in the AEW.Mk 5 and AEW.Mk 7 entries. Some in the Royal Navy favoured replacement of the type altogether, arguing that the veteran Sea King airframes could and should have been replaced by up to nine AEW-configured Merlins. These aircraft, it was argued, could have been spared because of the diminished Soviet submarine threat, and would have boosted export prospects for the type.

Sea King HAR.Mk 3



Sea King HAR.Mk 3

Extended rear cabin with relocated rear bulkhead and 'bubble' observation window

The age and inadequacy of the RAF's Wessex and Whirlwind SAR aircraft prompted early RAF interest in the Sea King, and an order for 15 Sea King HAR.Mk 3s was placed on 24 September 1975. These were serialised between XZ585 and XZ599. Search and rescue variants of the Sea King had already been ordered by Germany (Mk 41), Norway (Mk 43) and Belgium (Mk 48) and the HAR.Mk 3 was generally similar to these variants, with the same relocated rear bulkhead to give a longer cabin, the same long-reach winch, the same extra fuel tankage and with the same extra bubble observation windows and extra forward fuselage window on the port side. Like the Belgian aircraft, the HAR.Mk 3 was powered by the H.1400-1 engine of the HAS.Mk 2, and featured the same six-bladed tail rotor. The aircraft's avionics were generally similar to those of the HAS.Mk 2, with Decca TANS F computer, and Decca Mk 19 navigator and Mk 71 Doppler. The aircraft has Collins 618T

series HF, Sylvania ARC607 UHF and ARC115 VHF homers were also fitted and some also have maritime channel Chelton VHF/FM Channel 16 and Channel 67 homers and Omega INS computers. Pye Olympic VHF is used for communications with the police, mountain rescue teams, etc. A Smiths Industries 212SUE/1 autostabilisator replaced the Louis Newmark Mk 31 AFCS.

The first Sea King HAR.Mk 3 made its initial flight on 6 September 1977, and the type entered service with the RAF Sea King Training Unit at Culsrose in February 1978, and with No. 202 Squadron. The re-equipment of No. 202 Squadron was completed by the end of 1979. The disbandment of some of No. 202 Squadron's detached flights has freed some Sea King airframes, and consequently No. 22 Squadron has now virtually re-equipped with the Sea King. Completion of this re-equipment will be made possible when the six new-build Sea King HAR.Mk 3As

ordered in 1992 are delivered.

A 16th aircraft (ZA105) was ordered for ETPS, but was instead delivered for use by No. 78 Squadron and the RAF SKTU in 1980. Three extra Sea King HAR.Mk 3s were ordered in 1983, and these (ZE368-ZE370) were delivered during the late summer of 1985. They compensated for the

Sea Kings deployed to the Falkland Islands to equip No. 202 Squadron's 'C' Flight at Navy Point, which became No. 1564 Flight, and which later became a part of No. 78 Squadron, which also operated the Boeing Vertol Chinook. This unit now operates from RAF Mount Pleasant. There were initially three Sea Kings based in the Falklands, but today only two serve with No. 78 Squadron at any one time. The No. 78 Squadron aircraft are drawn from a pool of six specially modified aircraft (including XZ591, XZ597, XZ599, ZA105), which have Omega and Chelton VHF/FM homers but which also feature NVG-compatible cockpits, Navstar GPS and Racal RNS252 SuperTANS. They also have AVAD (Automatic Voice Alerting Device) which has a taped library of digitally stored warnings useful in high workload situations (for example, when using NVGs at low level). Most obviously, the aircraft are painted overall grey and are fitted with ARI 18228 radar warning receivers, with prominent antennas under the nose and below the forward end of the tailboom. They also have provision for the fitting of chaff/flare dispensers.

Replacing the Wessex in the SAR role, the Sea King had much greater range and could easily carry more survivors and rescue equipment.



Sea King HAR.Mk 3A

On 19 February 1992, an order was announced for six new Sea King HAR.Mk 3As to replace the last of the remaining SAR Wessexes. A Sea King HAR.Mk 3 simulator was ordered at the same time, and delivery of this will finally allow RAF airmen to free themselves from using the Navy's HAS.Mk 5 simulator at Culsrose. The aircraft are expected to feature a host of improvements, although perhaps not the nose-mounted Bendix weather radar and FLIR which were once mooted for the variant. They will have a Thorn-EMI ARI5955/2 digital colour search radar and a Smiths-Newmark SN500 FCS with fully-coupled flight-path control and full auto-hover. They will also be fitted with

Racal RNS252 SuperTANS, RNAV2 computer, and Decca Doppler 91, with a BAe GM9 compass, and Cossor STR2000 GPS giving much improved navigational accuracy. New communications equipment will include Collins HF9000 HF radio, Motorola MX-1000(R) mountain rescue radio and Rockwell-Collins AN/ARC-182 VHF/UHF. The new Sea Kings will be serialised from ZH540 to ZH545.

The RAF's HAR.Mk 3s are among the last Sea Kings to be delivered, along with two Mk 43Bs for Norway. The HAR.Mk 3A has improved communications.



Sea King HC.Mk 4

The Commando was developed as a private venture by Westland in 1972, but with the clear aim of securing an order from the Royal Navy to replace its Commando Wessex HU.Mk 5s. No such interest was forthcoming initially, and the aircraft was initially developed for export customers, with deliveries taking place from 1973. It was not until 1978 that the Royal Navy asked Westland to produce a study of a Commando variant to replace the ageing Wessexes then in use in the Commando role. Like the Egyptian and Qatari Commando Mk 2s, the aircraft for the Royal Navy (designated Sea King HC.Mk 4) were based on the Sea King HAS.Mk 2 powerplant and dynamic system, with H.1400-1 engines and six-bladed tail rotors. Folding main rotors and tail rotor pylons were retained. The aircraft had the same extended cabin as other Commandos and rescue Sea Kings, with the same extra windows on the port side, usually with the rearmost window a domed 'bubble'-type observation window. The aircraft had the standard Commando Mk 2 fixed undercarriage, without sponsons, albeit with provision for emergency flotation gear. The aircraft had the same UHF AM radio and IFF/SSR transponder as the HAS.Mk 5 (Magnavox AN/ARC-164 and Plessey PTR446A).

The first Sea King HC.Mk 4 (ZA290) flew on 26 September 1979, entering service with No. 846 Squadron on 26 November and immediately deploying to Norway for Exercise Clockwork. During the Cold War, the primary role of the Royal Marines Commando Brigade was to protect Norway's northern flank, and the Sea King HC.Mk 4 was procured primarily to support amphibious assaults and landing operations, flying in the logistics support, utility and troop transport roles. The primary role of the two Sea King squadrons (a third can and has been formed in times of crisis) is to be able to simultaneously lift two companies of No. 3 Commando Brigade (including 105-

mm guns, ammunition and vehicles) anywhere in the world.

Some 42 Sea King HC.Mk 4s have been built, two of these (ZF115 and ZG829) being delivered to Boscombe Down for trials or test pilot training duties. The first batch of 10 aircraft (ZA290-299) was delivered by September 1981 and was available for use in the Falklands, along with some aircraft from the second batch (ZA310-ZA314). These served with No. 846 Squadron and undertook a wide range of tasks, including many covert insertion missions. Four aircraft were Special Forces dedicated, operating from HMS *Hermes*. During one such mission, it is believed that the first Sea King HC.Mk 4 was deliberately sent on a one-way mission to insert SAS soldiers into Argentina to monitor movements at Argentinian airfields. The aircraft flew out to Chile, where it was burned by its crew, who then remained at large for some days (presumably to avoid any risk of compromising their former passengers) before reporting to the Chilean authorities. Night operations demanded the use of newly-delivered NVGs (ANVIS Generation 2s being used by crewmen and co-pilots, and Generation 3s by pilots). The squadron had no opportunity to practise overland NVG operations before its 1 May mission inserting SAS and SBS troops on the Falklands.

Operators of the HC.Mk 4 have included No. 707 Squadron (the conversion and training squadron, redesignated as No. 848 Squadron in February 1995), No. 845 Squadron (re-equipping in 1986), No. 846 Squadron and No. 848 Squadron (called to arms for the Gulf War on 6 December 1990). Five brand-new Sea King HC.Mk 4s (ZF120-ZF124) were delivered to No. 772 Squadron at Portland in February 1988 for operation in the transport and SAR roles. In the transport role, the squadron is tasked by the Flag Officer Sea Training and covers an area of sea adjacent to the coast between



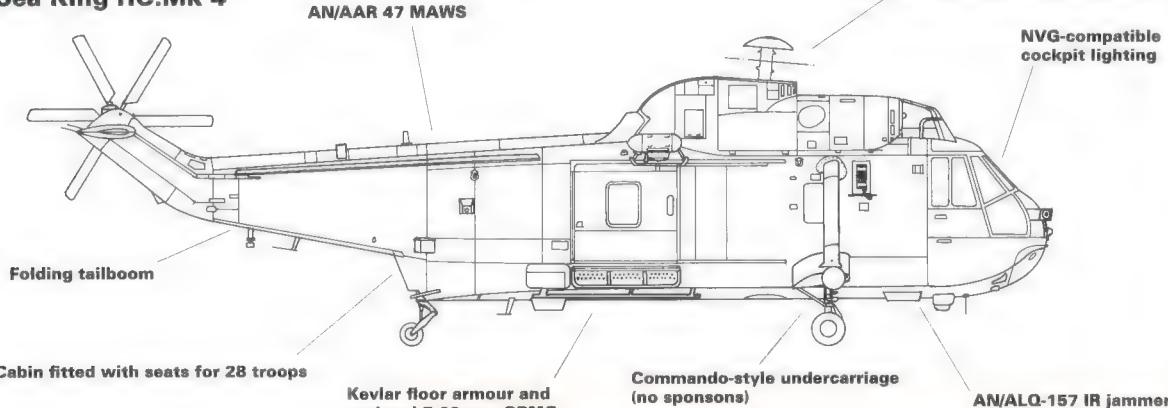
The Royal Navy's HC.Mk 4s are the main airlift force for the Royal Marines in Norway, but have also served in Northern Ireland and Iraq.

Brighton and Plymouth and inland as far north as Oxford. Sea King HC.Mk 4s normally have their AFCS disabled ('gagged out' in naval parlance) but it has been reinstated on No. 772 Squadron's aircraft for use in the SAR role. Other modifications include the provision of a tray-like plastic liner in the cabin, a Pye Beaver 12-channel maritime radio and a Chelton VHF channel Homer. The squadron flew with a single pilot during daylight, and with two at night, and usually also carried an aircrewman and a SAR diver. The squadron's aircraft have sometimes been erroneously referred to as Sea King HAR.Mk 4s, but no such designation actually exists.

The Sea King HC.Mk 4 has seen the most action among Royal Navy Sea King variants, first in the Falklands, then in the Gulf, then in Operation Haven in Turkey and northern Iraq and most recently over Bosnia. As is so often the case, operational action has led to many modifications and to the adoption of new equipment, without the

usual extended clearance procedures which accompany peacetime procurement programmes. NAVSTAR GPS, linked to the Racal RNS252 SuperTANS, was added for Operation Granby, along with AN/ALQ-157 IR jammers, M130 chaff/flare dispensers, improved IFF and communications equipment and NVG-compatible cockpit lighting. Most also had their 'barn door' intake filters replaced by APME Centrise air filters, similar to those fitted to export Commando variants. Door-mounted 7.62-mm GPMG machine-guns were also routinely carried. With full Granby improvements, all-up weight was increased, a typical fully-equipped aircraft weighing in at 14,400 lb (6530 kg). For operations over Bosnia, armoured crew seats and AAR-47 MAWS were added to No. 845 Squadron's Sea King HC.Mk 4s, along with frequency-hopping 'Have Quick' radio, Mode 4 IFF and Bright Star IR floodlight, and Grimes dual IR/white light landing light for compatibility with Nite-Op Generation 3 NVGs. Kevlar floor armour has also been fitted to some parts of the rear cabin, after several aircraft were hit by 7.62-mm small-arms fire over Bosnia. Lack of a weapon to reply to such incidents has caused concern. In order to address this requirement, the Royal Navy is to fit the HC.Mk 4 with a door-mounted FN-Herstal .50-calibre machine-gun fitted with a RING NVG-compatible sight, allowing the door gunner to gain a precise aiming point on a target before delivering highly accurate and very powerful return fire – also giving a useful air-to-air capability. The weapon will be able to use a variety of ammunition, such as special armour-piercing rounds, as opposed to the limited variety available for use with the current 7.62-mm GPMG.

Sea King HC.Mk 4



Sea King Mk 4X

The Sea King (and particularly the Commando-based HC.Mk 4) has proved to be a popular test and trials platform. Several have been used by MoD(PE) and its successor organisations. These included two specially prepared Sea King Mk 4Xs originally ordered for use by the RAE at Farnborough and Bedford. The two aircraft are basically standard HC.Mk 4s, but were delivered without dorsal-mounted Sea Searcher radomes. These have since disappeared and reappeared on the aircraft, but usually with the 'base-plate' left in place. ZB507 gained a LORAN-type 'towel rail' antenna on the upper part of the starboard tailboom while both aircraft have had changes to their nose contours in order to accommodate different test fittings and instrumentation packages.

The Sea King Mk 4X is operated by the DRA for trials of helicopter avionics, and is sometimes seen with only its radar baseplate.



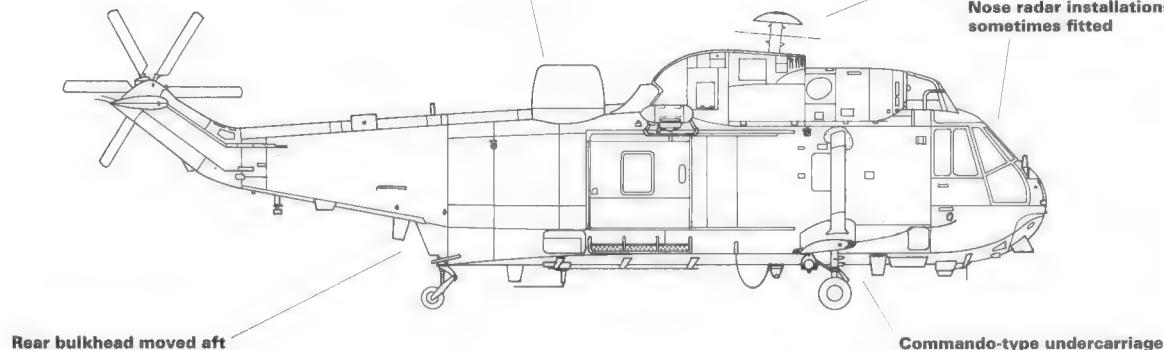
Sea King Variants

Sea King Mk 4X

Radome for MEL Super Searcher radar

Composite main rotors

Nose radar installations sometimes fitted



One of several additions to the Sea King Mk 4X is this chin radar trials fit, tested for the EH101.



Rear bulkhead moved aft

Commando-type undercarriage

Sea King HAS.Mk 5

The Royal Navy's ASW Sea Kings have been constantly updated and improved in service, leading to the appearance of a succession of variants. Perhaps the most dramatic step forward came with the introduction of the HAS.Mk 5. This featured the all-digital MEL Sea Searcher X-band radar. The new radar has selectable dual pulse widths to maximise range performance and discrimination in various sea states, and has roughly twice the range of the original Ecko AW391. Operator and helicopter interfaces were kept deliberately similar to those of the original analog radar, to make retrofit and operator retraining as easy as possible. The observer's station remains dominated by the large circular PPI display, which is inevitably described as being flat, although it actually slopes gently up and away from the observer. It is flat enough, though, to allow transparent maps and sheets to be overlaid.

The Sea Searcher was specifically developed for the Royal Navy, at an estimated cost of £4 million, and can be operated as primary or secondary radar. The operator can select a sector scan, showing only targets within a particular arc, or can operate a conventional 360° sweep. The display can show the helicopter stationary at the centre of the display (with other features moving relative to the aircraft) or can be shown 'flying' around the display, with fixed objects and the ground remaining stationary. Targets can be designated using a 'rolling ball' controller, and the display can be 'labelled' using stored digitally generated markers, and can show data from other aircraft systems. The fitting of Sea Searcher necessitated the use of a new antenna, located in a larger dorsal radome, with a flat top rather than the domed top of the original radome.

The new radar is augmented by Plessey Type 2069 dipping sonar, and by the use of SSQ904 and SSQ954 sonobuoys. Sonics information is processed by the new GEC-Marconi AQS902 LAPADS acoustic processing and display system. LAPADS was developed as a private venture, and is derived from the more sophisticated AQS901 sonics system used by the Nimrod

MR.Mk 2. The equipment is modular and weighs only 120 lb (54 kg), with a processor, receiver and hard copy chart recorder or CRT display. Sonar and sonobuoy information is received, converted into digital form, and then filtered and analysed to remove background noise. Thanks to LAPADS the Sea King HAS.Mk 5 can monitor signals from its own buoys, plus from sonobuoys dropped by RAF Nimrods, and can use passive or active sonobuoys. The sonar operator monitors LAPADS at an additional new crew station. Room was made for this by moving the rear bulkhead aft as in the Commando and in SAR versions of the Sea King. The aircraft also has the revised fuel tankage of the SAR versions. No extra windows were added, however.

The aircraft was also fitted with Racal MIR-2 ESM. Communications equipment included the Magnavox AN/ARC-164 UHF AM radio and Plessey PTR446A IFF/SSR transponder. The navigation system was updated with Racal TANS 9447G and Decca 71 Doppler. A number of HAS.Mk 5s are equipped with magnetic anomaly detectors. Entire starboard sponsons, incorporating the USN SH-3H's AN/AQS-81 towed MAD bird were purchased from Sikorsky and were fitted to Westland-built HAS.Mk 5 Sea Kings.

The first HAS.Mk 5 (XZ916) was a converted HAS.Mk 2 and made its maiden flight in its new configuration on 1 August 1980. It was rapidly followed by a second conversion. The first two HAS.Mk 5s were handed over to the Royal Navy on 2 October 1980 – without Sea Searcher radar, according to the contemporary Westland press release, which described the variant as merely having 'provision for MEL Sea Searcher to be fitted later'. Fortunately, whatever bugs resulted in the radar not being ready in time were ironed out, and subsequent HAS.Mk 5s were Sea Searcher equipped. The first aircraft was used for development flying by Westland until delivered to Boscombe Down on 12 November 1980. Thirty new-build HAS.Mk 5s were eventually ordered, in batches of 17 (ZA126-137 and ZA166-170), eight (ZD630-637) and five (ZE418-422) aircraft. The first new-build HAS.Mk 5 flew



The Sea King HAS.Mk 5 received a greatly improved radar and LAPADS acoustic processing. Most aircraft were eventually painted grey.

on 26 August 1980. The majority were produced by conversion of HAS.Mk 2 airframes at Fleetlands and Culdrose from 1981. The total number of conversions is understood to have been 55, comprising one HAS.Mk 1, 19 HAS.Mk 2s and 35 HAS.Mk 2As. One further HAS.Mk 2 used by Westland as a hack (XZ570) was converted to virtually full HAS.Mk 5 configuration with the designation HAS.Mk 2 (Mod). No. 820 Squadron became the first front-line HAS.Mk 5 unit in June 1981.

From 1989 the Sea King HAS.Mk 5 has been cleared for operation from Type 22 frigates, following trials by No. 826 Squadron, whose aircraft were permanently assigned to these vessels until the unit disbanded.

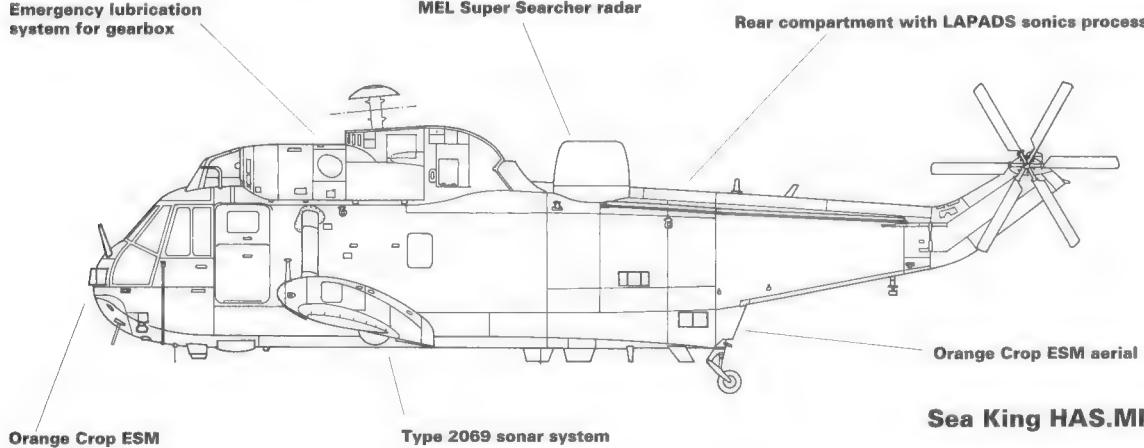
The Sea King HAS.Mk 5 saw active service during the operation to retake the Falkland Islands, and more recently participated in Operations Granby and Desert Storm. Although there was no perceived Iraqi submarine threat, Royal Navy and US Navy Sea Kings were deployed to the Gulf to be used in the mine

countermeasures and ASV roles. Stripped of sonar to give extra cabin space and to reduce operating weights, No. 826 Squadron's 'C' Flight deployed aboard the Dutch ship HNLMS *Zuiderkruis*, initially patrolling the southern part of the Persian Gulf to enforce UN sanctions, while also undertaking stores delivery missions to other allied ships in the area. The two aircraft replaced two Sea Kings from the same squadron's 'D' Flight, and had a fuller operational fit, with Trimble GPS, AN/ALQ-157 IRCM jammers, M-130 chaff/flare dispensers, RWRs, secure speech radios and a door-mounted 7.62-mm GPMG. Role equipment included Sandpiper FLIR in a turret hanging from the port side of the forward fuselage, Menagerie ECM, handheld thermal imaging equipment and Demon, a video-based mine-hunting system. Crews were expanded to include a diving supervisor and three divers. They were soon tasked as part of the Multinational Mine Countermeasures Force, providing a rapid-reaction mine detection and destruction unit. The two aircraft redeployed aboard RFA *Argus* and RFA *Sir Galahad* on 26 January, as the ground offensive drew near, clearing safe passages for the planned USMC amphibious assault which never took place. 'C' Flight was relieved by 'D' Flight on 27 April 1991, but the same two aircraft were handed over to the new aircrew. Between 13 December 1990 and 27 April 1991, the two Sea Kings flew 520 missions, locating 30 per cent of the moored mines detected before war began (and destroying 17 mines). During the war, the aircraft found 44 more floating and moored mines. Directly after the war, the mine-hunting Sea Kings deployed to Bangladesh for humanitarian relief duties under Operation Mana.

Emergency lubrication system for gearbox

MEL Super Searcher radar

Rear compartment with LAPADS sonics processing



Orange Crop ESM

Type 2069 sonar system

Sea King HAS.Mk 5

Sea King HAR.Mk 5

When the Royal Navy retired its last Wessex HU.Mk 5s in 1988, one squadron (No. 772 at Portland) re-equipped with Sea King Mk 4s. The other squadron, No. 771 at Culdrose, is now equipped with modified Sea King HAS.Mk 5s. The Sea King had demonstrated its potential in the SAR role during the Falklands War, and in RAF, German, Norwegian and Belgian service, while ASW Sea Kings had frequently demonstrated their secondary SAR capability. Because the Sea King HAS.Mk 5 had the same relocated rear bulkhead as the dedicated rescue aircraft and the Commandos, it had the same large-size cabin, although they lack the extra observation windows. Thus, when No. 771 Squadron's Wessexes were replaced by Sea Kings stripped of their ASW equipment, they were broadly equivalent to the RAF's HAR.Mk 3s, and were redesignated as HAR.Mk 5s.

Uniquely among rescue Sea Kings presently in service, the HAR.Mk 5s have MEL Sea Searcher radar, and not the ARI5995 radar of the HAS.Mk 1 and HAS.Mk 2. Most HAR.Mk 5s are externally distinguished by bright red-painted noses, tail booms (but not tail rotor masts) and undercarriage sponsons. Known HAR.Mk 5s include XV647, XV661, XV666, and XV705. There is some confusion as to whether ZE418, used by No. 771 Squadron in the SAR role, is actually an HAR.Mk 5 or an unmodified HAS.Mk 5. No. 819 Squadron at Prestwick operates a dedicated SAR flight, with two Sea King HAS.Mk 5s stripped of some of their sonar equipment. These aircraft are not HAR.Mk 5s, however. The government's drive to privatise services such as search and rescue make it unlikely that further HAR.Mk 5s will be procured or converted. The only station operating the HAR.Mk 5 is RNAS Culdrose, following the decision to disband 772 NAS at Portland.

The HAR.Mk 5 is the only British SAR model fitted with Sea Searcher radar, and has a highly distinctive red and grey colour scheme.



Sea King AEW.Mk 5

Anticipated attrition has reportedly led to a request for tenders in anticipation of a contract for the conversion of three redundant HAS.Mk 5 airframes (ZD636,

ZE418 and ZE420) to the AEW configuration under the designation AEW.Mk 5. It is understood that these aircraft will be converted directly to the advanced

AEW.Mk 7 configuration, based on a new radar, Mk XII IFF and JTIDS, as described under the AEW.Mk 7 entry. With the drawdown in ASW forces following the end of the Cold War, surviving ASW Sea King squadrons will probably eventually standardise on the HAS.Mk 6, leaving many

HAS.Mk 5s available for conversion to other roles. Some may be converted to AEW.Mk 5 standards for export, or to provide additional AEW cover for the fleet. Given the proliferation of navies with small carriers and no AEW cover, this may well be a viable conversion for these aircraft.

Sea King HAS.Mk 6

The HAS.Mk 6 has been erroneously described as an Advanced Sea King, although it lacked the Gnome H1400-1T engines, advanced five-bladed tail rotor, uprated main gearbox, or the redesigned fuel system which are associated with the Advanced Sea King model. It does have composite main rotor blades and the new fully integrated tactical mission system, and is receiving the new emergency lubrication system for the main gearbox. This machine offers a dramatic improvement in ASW capability pending the service entry of the EH101 Merlin, an development made possible only by the integration of new digital technology.

The new variant incorporates a new digital GEC Avionics AQS-902G-DS enhanced sonar system integrating data from the sonobuoys and the new Plessey/GEC Avionics Digital Type 2069 dipping sonar (basically the Plessey 195 sonar with digital processing), which has a much improved deep water capability. Sonar dunking depth has been increased to about 700 ft (213 m) from 245 ft (75 m). Some 31 of the new processors were ordered from GEC-Marconi in 1987, and the rest will be converted from the standard AQS-902C processor. Sonics information is presented together with information from the MEL Super Searcher radar on a single, integrated colour CRT display, considerably reducing crew workload. An improved communications suite includes a new GEC AD3400 secure U/VHF radio, served by a

broad blade antenna on the starboard side of the forward fuselage. This aerial provides the main recognition feature for the HAS.Mk 6.

Other new equipment includes a CAE Electronics internal AIMS (Advanced Integrated MAD System), GEC-Plessey PTR446 improved IFF, ESM upgraded to Orange Reaper configuration, and a pair of GEC-Marconi AD3400 VHF/UHF secure speech radios. The HAS.Mk 6 is 500-800 lb (227-363 kg) lighter than the HAS.Mk 5, this approximating to 30 minutes of extra fuel. In wartime, or on combat operations, this weight saving might be used to incorporate

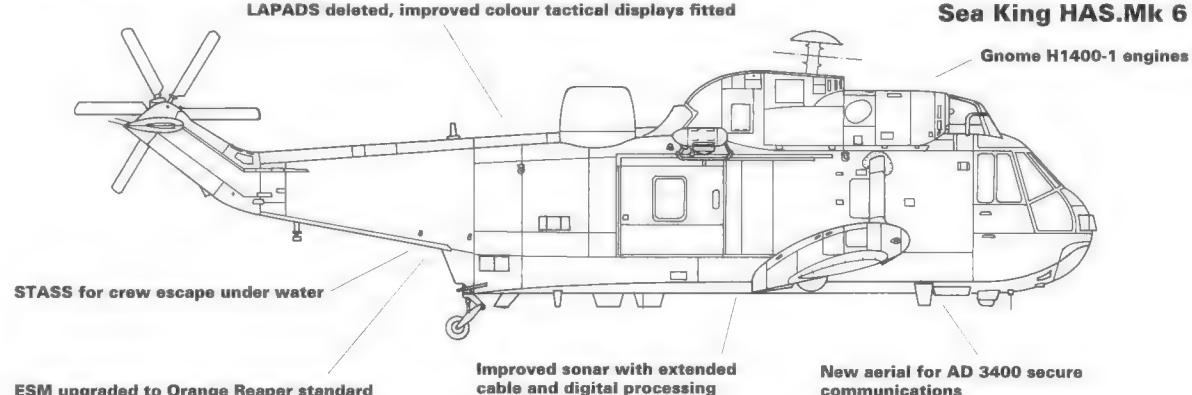
all or some of the features applied to Sea King HC.Mk 4s operating in Operation Grapple and described in the HC.Mk 4 entry.

The Sea King HAS.Mk 6 upgrade was not without its problems, of course. Many of the converted aircraft use extremely old and well-worn airframes, and this, combined with a spares shortage, caused major serviceability problems during 1993 and 1994. When added to the shortage of available submarines to train against, and the frequent non-availability of the RFA Argus, this forced changes to the RN training syllabus in which greater use was made of simulators. An improvement welcomed by Sea King HAS.Mk 6 crews (and one also being introduced on other

variants and other aircraft types) is the introduction of the new Short Term Air Supply System (STASS), a miniature compressed oxygen/nitrogen cylinder with an attached demand valve and mouthpiece, which is designed to give an extra margin for aircrew attempting to escape from a capsized or sinking helicopter. The air supply lasts for two minutes. The use of a nitrogen/oxygen mix reduces the risk of decompression sickness (the bends) although, when it is considered that a ditched Sea King can sink at a rate in excess of 600 ft (183 m) per minute, the risk cannot be entirely eliminated.

The HAS.Mk 6 is primarily an update of existing HAS.Mk 5 airframes. Twenty-five

Sea King HAS.Mk 6



Sea King Variants

kits were ordered for installation at Fleetlands, and the first converted HAS.Mk 6 (XZ581) made its maiden flight on 15 December 1987. A further batch of 44 kits followed, and 73 aircraft are now scheduled to be converted. Five new-build aircraft (ZG816-ZG819 and ZG875) were ordered in October 1987, and these were delivered between January and August 1990. The first new-build Sea King HAS.Mk 6 flew for the first time on 7 December 1989. The HAS.Mk 6 IFTU formed within No. 824 Squadron and received its first aircraft in April 1988. No. 819 Squadron was the first HAS.Mk 6 unit, re-equipping during April 1989. Today the Sea King HAS.Mk 6 partially equips No. 706 Squadron, the

The Sea King HAS.Mk 6 introduced a series of improvements that made life easier for the observer and greatly increased effectiveness.

Culdrose-based training unit, and the co-located No. 814 Squadron. No. 819 Squadron at Prestwick also operates a mix of HAS.Mk 5s and HAS Mk 6s and parents the HAS.Mk 6 OEU at Boscombe Down, while Nos 810 and 820 Squadrons at Culdrose are already fully equipped. Some HAS.Mk 6s have been seen with the extended starboard sponson associated with MAD gear, but it is not known whether this is still in use.



Sea King AEW.Mk 7

The Mk 7 designation had once been reserved for a Royal Navy Sea King with uprated transmission and possibly based on the Advanced Sea King configuration as exported to India. In May 1995 the MoD invited tenders for a mission systems update for the Royal Navy's 10 surviving

AEW.Mk 2s. The core of the update will be the provision of a new pulse-Doppler radar to replace the current Thorn-EMI Searchwater. Submissions so far include the new Searchwater 2000, and the GEC-Marconi Blue Vixen, while both Lockheed and Thomson-CSF are also

understood to have made proposals. The Blue Vixen would offer a degree of commonality with the Sea Harrier F/A-2, and the same contractor is also supplying the Blue Kestrel radar for the naval version of the EH101.

As well as replacing the radar, it is intended to incorporate and integrate Mk XII IFF equipment and a JTIDS terminal.

Since the relatively small AEW.Mk 2 fleet

has been used very intensively since its introduction in 1982 (and since the airframes converted then were already fairly well-worn HAS.Mk 2s), it may be assumed that the opportunity will be taken to refurbish the aircraft when the various new systems are incorporated. In the meantime, the update remains some way from finalisation, and, despite its vital importance, could still fall victim to defence cuts.

Sea King Mk 41

The first export customer for the Sea King was the West German Marineflieger, which ordered 22 aircraft to replace Grumman Albatross amphibians in the SAR role. The Marineflieger also showed interest in a mine-countermeasures version of the Westland-built Sea King similar to the Sikorsky RH-3A, with a Vermoor dual winch, towing boom and hook. In 1970, there was speculation that Germany would double or triple its Sea King order, and that some of the aircraft would be used in the ASW and ASV roles. This did not happen, and the SAR Mk 41s remained the only aircraft delivered, although they later gained an ASV capability with the BAe Sea Skua missile.

The Sea King Mk 41 was closely based on the Royal Navy's HAS.Mk 1 with the same MEL ARI.5955 radar (albeit with sonar and ASW role equipment removed) and was the first optimised search and rescue derivative. As such, it introduced the lengthened cabin (achieved without a fuselage stretch, simply by moving the rear bulkhead 5 ft 8 in/1.7 m further aft) and the extra pair of bubble observation windows at the aft end of the new cabin. An extra



Sea King Mk 42

Over the years, the Indian navy has received 41 Sea Kings, ranging from the earliest and most basic to the most modern Advanced Sea Kings. The first Indian Sea Kings were basically equivalent to the HAS.Mk 1, and Mk 41 with an improved cabin ventilation system and with some communications equipment tailored to Indian navy requirements. This included a Plessey ARI.18220/PTR.377 VHF /UHF radio, Dowty ARI.23159 emergency UHF, and D403M standby UHF, a Dowty UA.60M

Operating in conditions of extreme heat and humidity meant that one requirement of the Sea King Mk 42 was improved cabin ventilation.

intercom and Collins 618T SSB radio and transceiver. They had the same ARI.5955 radar, ARI.5954 I-band transponder, and AN/APN-171 radar altimeter as the HAS.Mk 1, and with the same Racal Decca Mk 19 and Collins marker and glideslope receivers as the German Mk 41. It has been suggested that an AQS 902 LAPADS acoustic processing and display system was



added after delivery.

Six Sea King Mk 42s were ordered in November 1969, the first of these making its maiden flight on 14 October 1970. This was delivered on 15 March 1971, with the last of the batch following on 23 August. These equipped INAS 330 shore-based at INS Garuda (Cochin) in the southwest of the country, but frequently deployed aboard INS Vikrant. These six aircraft operated from

shore bases during the 1971 war with Pakistan. A second batch of six Mk 42s was ordered in July 1972. The first of these flew on 17 July 1973 and deliveries took place between 28 September 1973 and 4 July 1974. The delivery of the second batch allowed the formation of INAS 336 at the same base, which functioned as the OCU and as an extra squadron for the *Vikrant*. All Indian Mk 42s were delivered by air, in RAF

Short Belfasts operating from Brize Norton and Fairford. At least five Sea King Mk 42s have been written off, and the survivors, together with the Sea King Mk 42As are now concentrated within INAS 330. The Sea King Mk 42s wore a dark glossy blue finish, with white upper decking. As with all Indian navy aircraft, the navy legend is applied in English to port and in Sanskrit to starboard. 1992 reports of a Thai order for six ASW

Sea Kings used the Mk 42 designation, but these would have almost certainly had a new designation (perhaps Mk 52) had the order gone ahead. These would have been deployed aboard the Thai's new 15,000-tonne carrier built in Spain by Bazán, which will now operate the ex-Spanish Navy AV-8A Matadors which Thailand is receiving. India is unlikely place any further orders for the Sea King before production ends.

Sea King Mk 42A

A batch of three extra Sea Kings was ordered in 1979. These were broadly equivalent to the Royal Navy HAS.Mk 2 with Gnome H1400-1 engines. They were equipped with a 'haul-down' facility to allow operation from small ships. Ordered in June 1977, the first of the three Mk 42As made its maiden flight on 23 November 1979, with deliveries following in March 1980. The aircraft were delivered via Stansted. Today these aircraft serve alongside the surviving Mk.42s with INAS 330 at Cochin. The significance of these aircraft has recently

The Indian Navy has purchased 41 Sea Kings in four versions, more than any other export customer. The Mk 42s serve with INAS 330 at Cochin on anti-submarine duties.

increased because of the acquisition of new French-built submarines by Pakistan. Unusually, India also operates the Soviet-built Kamov Ka-25 'Hormone-A' in the anti-submarine warfare role, an interesting complement to the larger Sea King.



Advanced Sea King Mk 42B

The most powerfully-armed Sea Kings are India's Mk 42Bs, capable of destroying ships over 110 km away with Sea Eagle missiles.

before delivery to the Indian navy, was reserialled by the superstitious Indians from IN513 to IN532. India exercised its option for eight further Mk 42Bs, which directly followed the first 12 off the line. The first aircraft made its maiden flight on 17 May 1985 (as ZF526) and was finally delivered on 10 December 1990 (the last Sea King received by the Indian navy). The first of the Mk 42Bs to be delivered to the customer was IN518 on 20 February 1989. All of the Mk 42Bs were delivered by sea, via Tilbury. MK 42Bs were delivered by sea, via Tilbury.



Advanced Sea King Mk 42B

**Improved performance
Gnome H.1400-1T engines**

Provision for Sea Eagle missiles

Advanced composite main rotor blades

MEL Sea Searcher radar

Advanced composite five-bladed tail rotor

The Indian Mk 42Bs serve with INAS 336, shore-based at Cochin, but regularly deployed aboard the carriers *Viraat* and *Vikrant*, and the indigenous 'Godavri'-class frigates (enlarged 'Leanders' with hangarage for a pair of Sea Kings). The Sea King Mk 42Bs were delivered in an overall light grey colour scheme, instead of the gloss blue and white scheme worn by the original aircraft. The initial batch of 12 aircraft actually consisted of 13 aircraft from the Yeovil line; one ditched in the Mediterranean during pre-delivery trials and was replaced by a second wearing the same serial. The first aircraft, retained as a development aircraft and demonstrator

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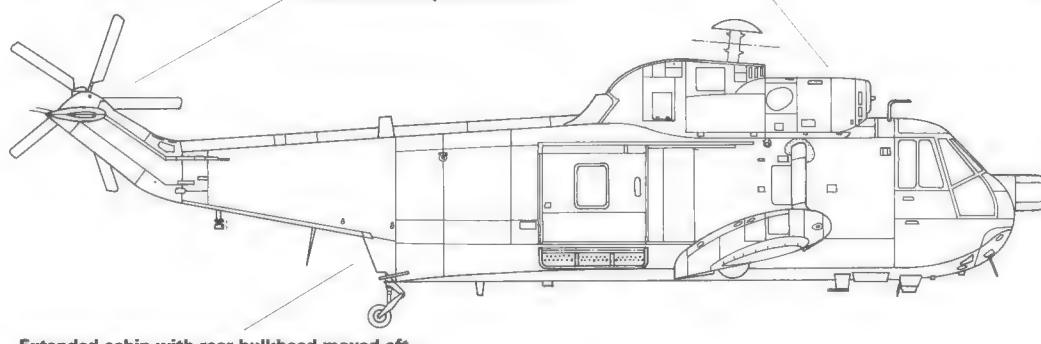
Advanced Sea King Mk 42C

The Sea King Mk 42C is a dedicated utility transport and SAR version of the Advanced Sea King, and is sometimes incorrectly referred to as the Commando Mk 42C. Its avionics are similar to those of the RAF's Sea King HAR.Mk 3s, but with a nose-mounted Bendix radar and some local avionics equipment. It is uncertain as to whether the aircraft have the stretched cabin of many dedicated rescue versions. They do not have the extra pair of bubble observation windows. The first of the Mk 42Cs made its maiden flight on 25 September 1986 and delivery of the six took place between 5 February 1987 and 1 November 1988. These aircraft were delivered by sea, leaving the UK via Tilbury, and arrived before the more sophisticated Mk 42Bs. The Mk 42Cs are allocated to INAS 339 at INS Margar but are divided between the eastern and western fleets, operating mainly in the VertRep role in support of India's two carriers, *Viraat* and *Vikrant*. The designation Sea King Mk 42D

Gnome H.1400-1 engines

Five-bladed composite tail rotor

Bendix radar



was reportedly reserved for a proposed AEW Sea King for India, and whose present status remains uncertain.

Sea King Variants

Sea King Mk 43 and Mk 43A

Norway ordered 10 Sea Kings in 1970 to provide military and civilian SAR cover along the hazardous Norwegian coastline and in the country's equally treacherous mountains. The resulting Sea King Mk 43 is a dedicated SAR aircraft broadly equivalent to the German Mk 41, and is thus based on the RN's HAS.Mk 1 airframe and engine, with the SAR-style lengthened cabin, extra bubble windows and enlarged fuel tankage. Avionics are broadly equivalent to those of the German Sea King as originally delivered, without TACAN or Micro TACAN, without the all-weather landing system, without IFF but with a Collins AN/ARC-51BX UHF AM transceiver, with a Collins Italiana MR-201 VHF FM transceiver and a Collins VHF-20 radio, and with the addition of Becker ZG2 VHF homing. The first of 10 Mk 43s made its maiden flight on 19 May 1972 and deliveries took place between November 1972 and October 1973. The aircraft equip 330 Skvadron headquartered at Bodø with operational flights at Bodø (A Flight), Banak (B Flight), Ørland (C Flight) and Sola (D Flight). Two have been written off in service, and another two have been rebuilt after accidents, one to Mk 43B standards. All surviving Mk 43s are being similarly upgraded under the terms of a 1989 contract issued to Westland.

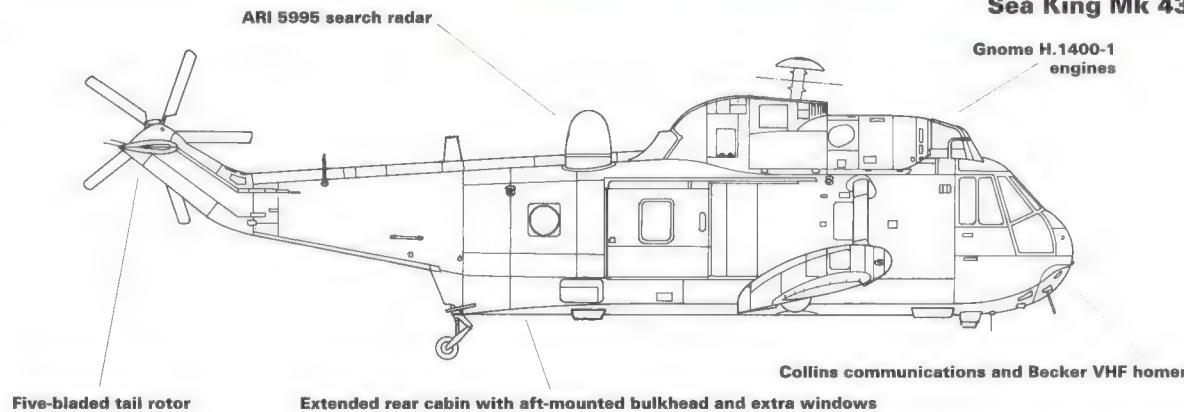
A single Sea King ordered in 1978 was delivered with the uprated transmission and six-bladed tail rotor of the HAS.Mk 2, but with the basic H1400 engines and with the same avionics and equipment as the earlier Norwegian Sea Kings. This one-off was the sole Mk 43A (with the serial number 330) which first flew on 6 July 1978 and was

delivered on 9 October the same year. The aircraft has already been upgraded to Mk 43B standards. Like other Norwegian Sea Kings, it wears a high-visibility red and white colour scheme. The new Mk 43Bs in production at Westland will probably be the last new of the line, along with a final batch of HAR.Mk 3As. These modernised Sea Kings are likely to serve until at least 2010, and may possibly be replaced by the EH101.

Norway operates the Mk 43 Sea King, now being upgraded to Mk 43B standard with the addition of a FLIR turret and weather radar.

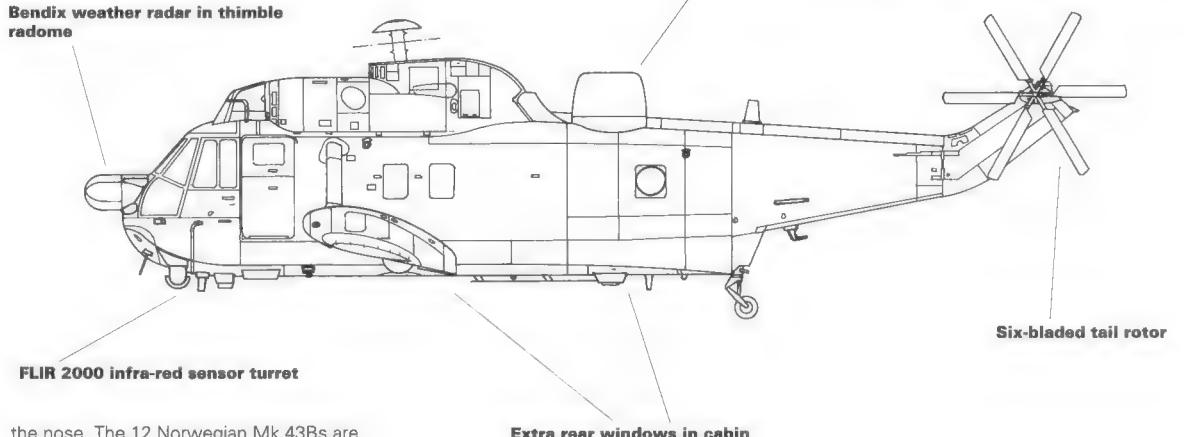


Sea King Mk 43



Sea King Mk 43B

All Norwegian Sea Kings will eventually be Mk 43Bs, with the surviving 43s being converted to this standard by Westland. The first Mk 43B was 071, which was rebuilt to the later configuration after a ditching incident on 21 May 1991. In addition to the conversion of the existing Mk 43s and the single Mk 43A, one new-build Sea King Mk 43 was delivered in mid-1992 and two more new-build aircraft were due to be delivered from Westland during 1995. The Mk 43B is a unique hybrid, since it embodies features from a variety of other Sea King variants. The tiny thimble radome on the spine, and its associated ARI.5955 radar, have been replaced by a larger flat-topped radome housing the antenna for the MEL Sea Searcher (as carried by the HAS.Mk 5). In addition to this powerful search radar, the aircraft has a Bendix/King weather radar in the nose, with a small offset radome to port of the centreline. New avionics systems include Racal Doppler 91, RNAV 2 and Mk 32 Decca Navigator. A FLIR Systems FLIR 2000 turret is carried below the port side of



the nose. The 12 Norwegian Mk 43Bs are expected to serve well into the next century with their new equipment fit.

Sea King Mk 45

With the Mk 44 designation deliberately omitted to avoid confusion with the similarly designated torpedo, the Mk 45 designation was the next available when Pakistan placed its order for six ASW Sea Kings in December 1972. The 1971 war with India had demonstrated a major shortfall in ASW capability and this prompted the formation of a separate naval aviation element. Among the first priorities of the new force was the procurement of effective ASW helicopters.

The first Mk 45 flew on 30 August 1974, and deliveries took place between October 1975 and November 1977. The aircraft were delivered by sea after being crated at RNAY Wroughton. The Sea King Mk 45s were broadly equivalent to the Royal Navy HAS.Mk 1 and the Indian Mk 42, with the same MEL ARI.5995 radar, Plessey Type 195M sonar, a Dowty D403M standby UHF radio and an MEL ARI.5954 I-band transponder, but with a General Instrument ALR-606 RWR.

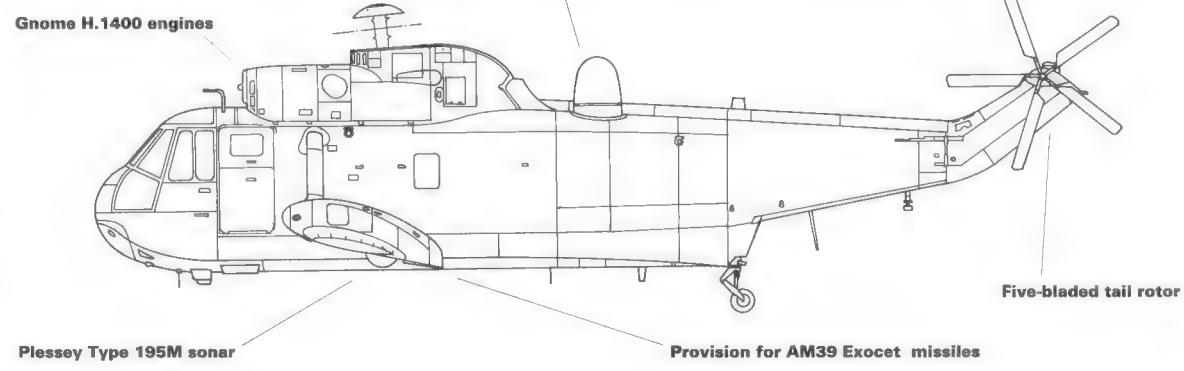
Five of the Pakistani aircraft were modified for a secondary ASV role with provision for the Aérospatiale AM39 Exocet ASM. Initial dropping trials were carried out

on the ranges at Larkhill by 4514, which had its serial, British civil registration and Pakistani national insignia airbrushed out in many Westland photos, but retained its huge NAVY titles in white and the characteristic white-painted radome. The same aircraft went on to conduct live firing

trials at St Raphaël (and/or Cazaux, according to some sources) during April to June 1976 and June to October 1977. Today the aircraft equip No. 111 Squadron (the 'Sharks') shore-based at the naval base (known as PNS Mehran) at Sharea Faisal, which also accommodates army and air

force flying units. The Sea Kings can also operate from the Navy's destroyer and frigates, although they are unlikely to operate from Pakistan's Type 21 frigates which have their own Lynx. The Mk 45s are all painted in a smart dark blue scheme with white-painted radomes.

Sea King Mk 45





Left: Like most of the world's Sea Kings, Pakistan's aircraft often find themselves carrying out SAR missions while on other duties.

The Pakistan navy has only ever fired Exocet missiles in peacetime, but its Sea Kings are a powerful asset in the region's seas.



Sea King Mk 45A

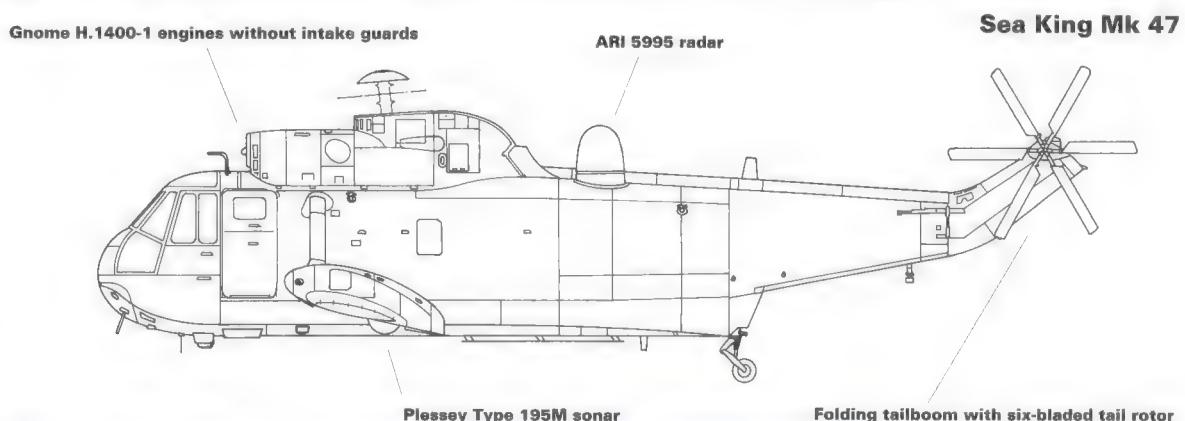
A single Royal Navy HAS.Mk 5 was withdrawn from use and converted to Mk 45 standards to act as an attrition replacement for one of the original Pakistani aircraft that crashed during 1986. This aircraft (originally ZE421) first flew in its new configuration on 17 December 1988 with a new serial (ZG935), prior to adopting its eventual Pakistani identity. It was shipped via Tilbury on 11 January 1989. It is believed that this aircraft is the only Pakistani Sea King not compatible with the AM39 Exocet anti-ship missile. Pakistan's naval air arm is now far more powerful than it was only two years ago, as the service now operates six Westland Lynx HAS.3s in addition to the Sea Kings, which are operated from the Type 21 (ex-'Amazon' class) frigates sold to Pakistan by the Royal Navy. These vessels are too small to operate the Sea King.



Sea King Mk 47

With the Mk 46 designation omitted to avoid confusion with a similarly designated torpedo, the next Sea King variant was the Mk 47. Saudi Arabia ordered six ASW Sea Kings on behalf of Egypt in 1974, following the initial order for five Commando Mk 1s. The Sea King Mk 47 was basically similar to the Royal Navy HAS.Mk 2 and the Australian Mk 50, with virtually the same avionics and equipment fit but with the original Plessey Type 195M sonar as fitted to the HAS.Mk 1. They were painted in an unusual medium blue colour scheme, with light grey undersides and a white radome. The first aircraft made its maiden flight on 11 July 1975 and was delivered to Culdrose for training Egyptian aircrew on 29 August, finally being delivered to Egypt on 18 May 1976. The six aircraft are based at Alexandria for ASW duties, and were delivered as air freight from Hurn. They will soon be operating in concert with Kaman SH-2G Seasprites, recently purchased from the United States. Egypt is also one of the world's last military seaplane operators, with a handful of Beriev Be-12 'Mails' still flying in the anti-submarine role. The Mediterranean is a challenging environment for ASW operations as it is a shallow sea with a large number of wrecks which often show up as possible contacts. The main trade for the Sea Kings are probably Libyan submarines, some of which still manage to go to sea. Apart from ASW duties, the Egyptian Mk 47s are all winch-equipped and can perform SAR missions. Unusually for Egyptian aircraft, they are not often seen with sand filters fitted, presumably as the aircraft spend most of their time over the sea rather than over the desert, and do not incur the consequent engine wear.

The Sea King Mk 47 is another rarely seen variant, with only six examples operated by Egypt. They are comparable to the HAS.Mk 2.



Sea King Variants

Sea King Mk 48

Belgium ordered five Sea Kings for SAR duties on 22 April 1974. These were broadly similar to the RAF's HAR.Mk 3, combining the rescue-type airframe of the German and Norwegian aircraft with the engines and tail rotor of the HAS.Mk 2. The first of the Mk 48s made its maiden flight on 19 December 1975, and it and the other aircraft were initially sent to Culdrose for crew training. The aircraft were delivered with virtually the same full IFR avionics fit as the German Sea Kings. The Sea Kings were delivered to Escadrille 40 (40 Smaldeel) at Koksijde by the autumn of 1976, where they augmented the unit's S-58s, taking over the entire SAR commitment in December 1978 and all other duties in July 1986, when the last S-58 was retired.

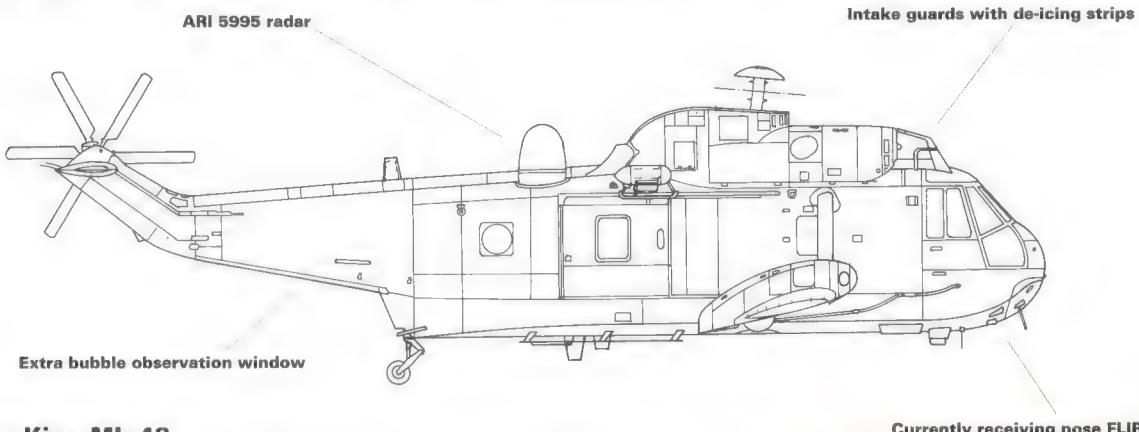
SAR coverage for some of the busiest shipping lanes in the world, along the English Channel, is the responsibility of Belgium's Mk 48 Sea Kings, based at Koksijde.

The Sea Kings undertake civilian and military tasks plus the Belgian SAR commitment as laid down by NATO and the 1947 Chicago Convention, covering the Belgian SAR region which extends over Belgium, Luxembourg and a large section of the North Sea. The aircraft are tasked from a Rescue Co-ordination Centre in Brussels, with Rescue Sub-Centres at Koksijde and Luxembourg. The aircraft have secondary VIP, troop transport, parachute jumping, underslung load, medevac, organ delivery and paramilitary and police duties, and even assist when heavy sea conditions make it impossible to provide the normal pilot



service for ships inbound to Flushing. The aircraft were retrofitted with composite main rotor blades during the 1980s, and also received a major navigation systems update.

Intake guards with de-icing strips



A request for proposals for an upgrade for the five Belgian Sea Kings was finally issued in August 1993 (by which time the five aircraft had clocked up over 29,000 flying hours), and a £245 million (£4.5 million) contract was awarded to Westland (providing upgrade kits for incorporation by the Belgian company SABCA) in December 1993. The first upgraded Sea King (RS05) was rolled out by SABCA (Société Anonyme Belge de Constructions Aéronautiques) on 3 May 1995. The modification sees the aircraft retrofitted with a Bendix RDR1500B radar, a new enlarged dorsal radome, and a FLIR Systems FLIR 2000F turret mounted below the port side of the nose. The navigation suite is improved by the addition of a Racal RNS252 INS and a Canadian Marconi CMA3012 GPS which can be pre-programmed on the ground using a digital cassette. Having spent most of their working lives at low level over the sea, the aircraft are showing some signs of corrosion and fatigue. The 98th Logistics Battalion at Ypres is to refurbish and refit the aircraft, and may also undertake a cockpit upgrade based on the Norwegian Sea King 43B cockpit. The upgrade will keep the aircraft viable until at least 2010.

Sea King Mk 48

Sea King Mk 50

Ten Sea Kings were ordered for the Royal Australian Navy in 1972 to replace Westland Wessexes in the ASW role. The Australian Sea King acted as the prototype for the second generation of Sea Kings, powered by the more powerful H1400-1 engines and with improvements to allow the extra power to be used. These improvements included a strengthened transmission system, with improved main, intermediate and tail rotor gearboxes and with a new six-bladed tail rotor. These refinements allowed maximum all-up weight to rise to 21,000 lb (9525 kg) and offered much improved hover and 'hot-and-high' performance. From a mission avionics point of view, the Mk 50 was broadly equivalent to the HAS.Mks 1 and 2, although the Australian aircraft differed in being equipped with the American Bendix Oceanics AN/ASQ-13A dipping sonar, SEL AN/ARN-52 TACAN, Collins Canada DF-301E UHF direction finding, Collins AN/ARC-159 UHF AM radio and 618T HF SSB radio, a Hazeltine AN/APX-72 IFF transponder and an EXDAC datalink. The ASQ-13A gave greater compatibility with RAAF Lockheed Orions, and had over 500 ft (150 m) of cable (100 ft/30 m more than the Plessey sonar of early RN Sea Kings). The aircraft were also

Australia's Sea Kings have now reverted to a shore-based role for coastal ASW, as they proved too large for operation from the RAN's American-built FFG-7 frigates.

fitted with a winch-operated refuelling system, which allowed the aircraft to refuel from ships while in flight, without having to alight. With this system, the Sea King's endurance was effectively limited only by crew fatigue.

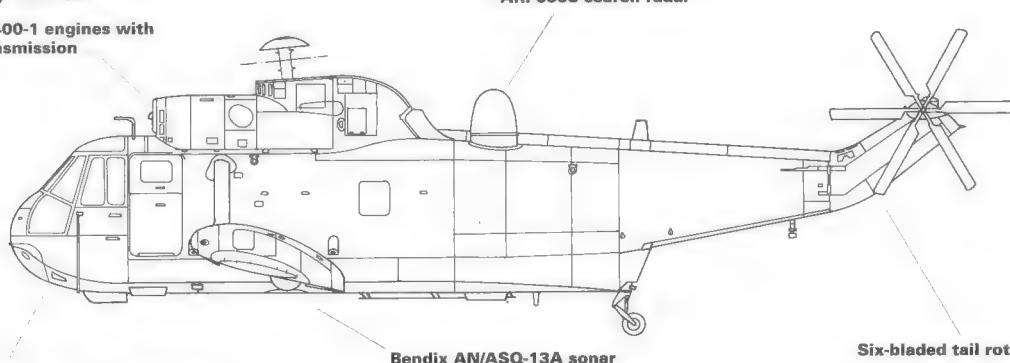
The first of the Mk 50s flew on 30 June 1974 and the aircraft were initially delivered to Culdrose for aircrew training. The aircraft were crated at Ilchester before shipment to Australia. The Sea King Mk 50s allowed the reformation on 2 February 1976 of HS-817, which initially operated from HMAS Melbourne and would doubtless have gone on to serve on the vessel's replacement, which was to have been the Royal Navy's HMS Illustrious. After the Falklands War the UK withdrew its offer to sell the vessel to Australia, who balked at the cost of commissioning a new replacement. Plans to operate the Sea Kings from Australia's FFG-7 frigates came to nothing after trials revealed that the aircraft were too large to conduct routine operations from such ships, and instead operated in the shore-based coastal ASW role. One published source has



suggested that the Australian Sea Kings were updated with MEL Sea Searcher radar, but there seems to be little evidence to support such an assertion.

Sea King Mk 50

Gnome H.1400-1 engines with uprated transmission



Collins UHF-DF and AN/ARC-159 radio



Australia's Sea King Mk 50s were unusual in that they were fitted with Bendix AN/ASQ-13A sonar, which proved very successful in service.

Sea King Mk 50A

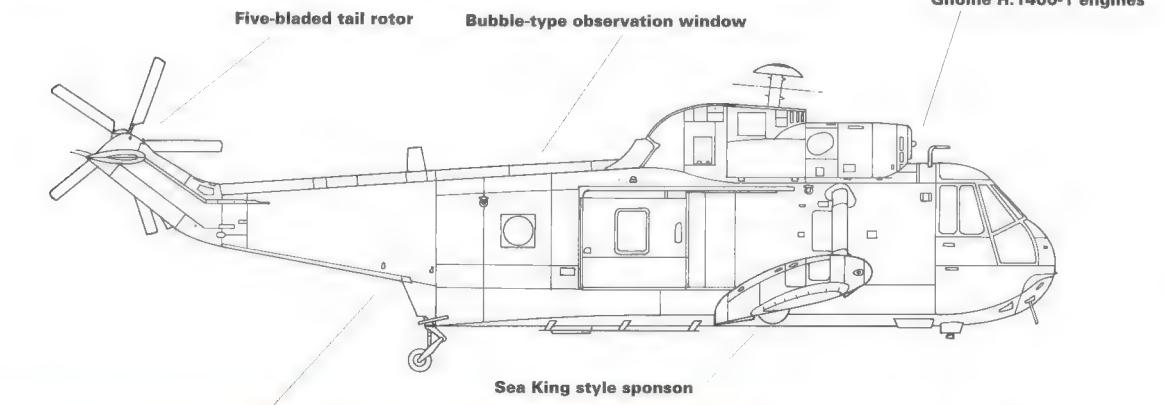
Two attrition replacements ordered in 1981 were designated Mk 50A. These were broadly equivalent to the Mk 50 but featured the relocated rear bulkhead associated with the HAS Mk 5, which gave a longer cabin. The aircraft are externally indistinguishable from the Mk 50, and are believed to have exactly the same avionics fit. The first of the pair made its maiden flight on 7 December 1982 and was delivered on 22 February 1983. Like the surviving Mk 50s, the two Mk 50As were effectively withdrawn from ASW operations when finally replaced by the Royal Australian Navy's newly acquired S-70B-2 Seahawks, which served with HS-816. Shipborne flying is also carried out by the Eurocopter Squirrels of HC-723, albeit in a far less capable way than was possible with

the Sea King. The seven surviving redundant Sea Kings then replaced the Westland Wessexes of HC-723 in the utility role, although they remained assigned to HS-817. Their tasks included military and civilian SAR, VertRep, transport and SAS support. At about the same time as they relinquished the ASW role, during 1990, the Australian Sea Kings received composite main rotor blades which require less maintenance than metal blades, can be operated in a wider temperature range and give less vibration. Despite the loss of the role for which they were intended, these Sea Kings will probably remain in service for many years yet, a testimony to the design's versatility.

Externally identical to the Sea King Mk 50, the Mk 50A has a slightly longer rear cabin. All Australian Sea Kings now have composite rotors.



Commando Mk 1 (Sea King Mk 70)



Sea King cabin without ASW mission equipment



Commando Mk 1 (Sea King Mk 70)

The dedicated troop-carrying Commando was developed as a private venture and export customers for the aircraft were found long before the British armed forces expressed any interest in the type, although the Royal Navy did eventually order the variant under the designation Sea King HC.Mk 4. A land-based transport version of the Sea King was first projected by the Design Office at Yeovil in 1972, and the marketing department quickly applied the name Commando, in a deft recollection of the Wessex Commando Mk 1, and Wessex

The Commando Mk 1 was only different from a Sea King in having an empty rear cabin with extra windows and more fuel capacity.

Commando HU.Mk 5, although the Commando epithet had, in truth, been little used. From the very start, Westland realised that the prospect of an RAF order was remote, since the service had just ordered the Puma as its Wessex replacement, and would not want to order a larger helicopter which might prejudice its chances of getting the Chinooks it desperately wanted to fulfil its MLH requirement. The company had high hopes of attracting a Royal Navy order as a replacement for the Commando Wessex, and even showed an aircraft wearing Army titles and Scout-type brown and green camouflage in its initial publicity material. But if the land-based transport Sea King had been unashamedly aimed at the British forces, it was the Arab Republic of Egypt which was to place the first order. The Commando Mk 1 (which also carries the Sea King Mk 70 designation, though this is little used) was something of an interim type, lacking several of the features which had been expected to appear on the production Commando. It was, in reality, not a Commando as such, but a basic troop-carrying version of the initial Sea King HAS.Mk 1 with sonar, radar and ASW equipment removed and with the larger cabin and increased fuel capacity of the Sea King Mk 41. The extra bubble observation windows were retained on both sides of the cabin. The Commando Mk 1s had the original five-bladed tail rotor and the basic Gnome H.1400 engines, and, surprisingly, retained standard Sea King undercarriage sponsons with flotation gear, and folding main rotor blades. No radar or radome was fitted. The first Commando flew for the first time on 12 September 1973, and the aircraft were delivered from 29 January 1974. They have been supplemented by the improved Commando Mk 2, which can be easily distinguished from the Mk 1 (despite their identical colour schemes) by the newer undercarriage without sponsons. Egypt also uses the VIP-transport Commando Mk 2B.

Commando Mk 2 (Sea King Mk 72)

With the successful sale of Commando Mk 1s to Egypt, Westland refocused its attention on the export market for its troop-carrying Sea King derivative. The company's strongest sales prospects were in the Middle East and Far East, and it became clear that performance of the Commando would have to be maximised to cope with 'hot-and-high' conditions. Accordingly, Westland combined the airframe of the Commando with the H1400-1 engines and six-bladed tail rotor of the HAS.Mk 2 and Mk 50 to produce the Commando Mk 2. The variant was the first true Commando version, with the various weight-saving features which had always been planned. Weight was saved by fitting non-folding main rotor blades and a simplified fixed undercarriage, and by removing the sponsons. The removal of the hydraulic blade-folding mechanism alone saved 200 lb (91 kg). The integral flotation gear was replaced by easily removable flotation packs, which took the form of small discs attached to the end of the stub wing (which had no aerodynamic function, despite being known as a stub wing). The removal of the undercarriage sponsons also improved the

aircraft's ability to carry weapons, by clearing the stub wing and providing an optional wingtip hardpoint outboard of the undercarriage. This, it was felt, could be used for the carriage of auxiliary fuel tanks or guided weapons such as the AS12, Martel, Kormoran or Exocet. The underwing hardpoints were to be used for the carriage of rocket pods, or gun pods containing a single 20-mm cannon (and 300 rounds) or twin 7.62-mm machine-guns (with 950 rounds), or even for the carriage of 500-lb bombs. In fact, the underwing and wingtip hardpoints have not been used by the aircraft's customers.

Like the Commando Mk 1, the new version retained the stretched cabin and increased-capacity fuel tankage. Early proposals included the fitting of inflatable seats, with 26 outward-facing seats along the centreline and with two rear-facing conventional seats against the forward

The Commando Mk 2 is easily distinguished from the Mk 1 by the new type of undercarriage. It also lacks rotor-blade folding.

bulkhead. These were designed by Westland's FPT subsidiary, and were claimed to offer major weight savings. The inflatable seats were made in six- or eight-seat back-to-back units, spreading weight equally over the floor area and providing excellent energy absorption in the event of a crash landing. The full 26 seats, it was calculated, would also give some 3,000 lb

(1360 kg) of extra buoyancy in the event of a ditching. Seatbelts passed through strengthened tubes in the seats to anchor to the standard floor points. The seats were also quick and easy to install, and could simply be deflated and rolled up for stowage when not in use. The lack of a full-width 'tactical-type' door on the port side made the use of outward-facing seats



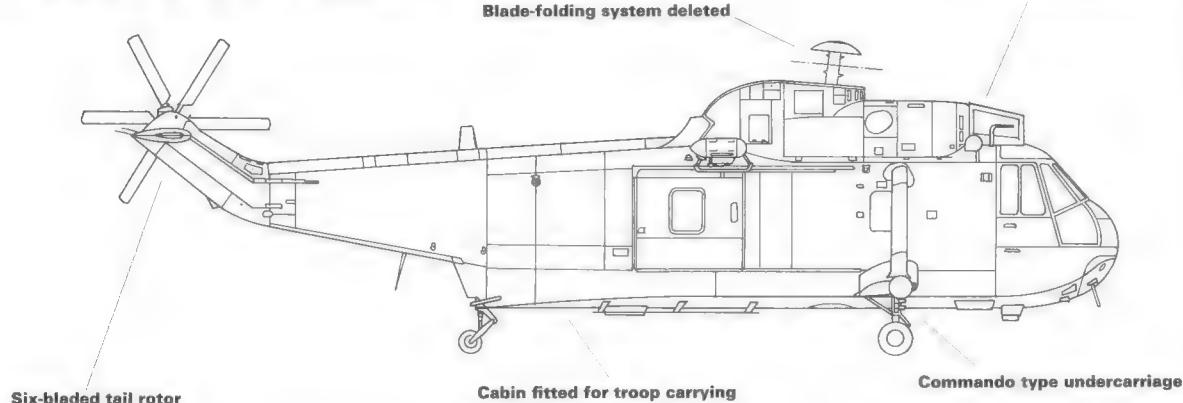
Sea King Variants

impractical, and customers were not ready to accept the idea of inflatable rubber seats. In the real world, operators have

preferred to stick to more conventional canvas seats, installed facing inwards along the cabin walls and forward bulkhead. In a

fairly standard configuration, this gave 28 seats, although a maximum of 34 fully armed troops could be carried if necessary,

Commando Mk 2 (Sea King Mk 72)



depending on range. The 28 seats consisted of three along the forward bulkhead, nine more along the starboard side forward of the door, with two more behind it, and with 14 more along the port cabin wall. The extra windows associated with the stretched cabin were retained only on the port side, and this was flat rather than the domed bubble fitted to the British HC.Mk 4 and much-used during fighter evasion. This window was retained on all subsequent Commando Mk 2 sub-variants.

Westland's efforts were rewarded by a 1974 Saudi order for 19 Commandos, 17 utility Mk 2s and two VIP transport Mk 2Bs for Egypt in a 10-seat luxury fit including a galley, toilet and soundproofed rear cabin. These aircraft are sometimes seen fitted with sand filters. The initial Qatari order for three Mk 2As and a Mk 2C was placed almost simultaneously. The first Commando Mk 2 flew on 16 January 1975, and was delivered on 21 February. The last was delivered on 14 February 1976. The aircraft are now based at Almaza. Most of the Commando Mk 2s were airfreighted from Hurn, but two left from Brize Norton.

Commando Mk 2A (Sea King Mk 92)

The Commando Mk 2A was, to all intents and purposes, identical to the Egyptian Mk 2. Whereas the Egyptian aircraft were predominantly desert sand in colour, with only the undersides in grey, the tops and sides of the Qatari Mk 2s wore a two-tone disruptive camouflage similar to that applied to the tiny nation's Hunters, Mirages and Alpha Jets. Like the Egyptian Commandos, the Qatari aircraft were capable of being used in the casevac and air ambulance role, as well as for trooping. The Commando's large cabin allows a variety of seating and stretcher layouts, with capacity for up to nine stretchers with seated attendants or 'walking wounded' casualties. A 'clip' of three vertically stacked stretchers would take up the same space as six seats. The Commando also has a formidable cargo-carrying capability either internally or underslung. Using a standard sling, the Commando can carry a maximum of 6,000 lb (2720 kg), but 8,000 lb (3630 kg) can be

carried if a low-response sling is used. Internally, the cabin is 25 ft (7.6 m) long and has a floor stressed for loads of up to 200 lb/ft² (14 kg/cm²). Maximum payload is 9,500 lb (4310 kg), allowing light vehicles and artillery to be lifted. The first of the Qatari Commandos made its maiden flight on 9 August 1975 and was delivered on 10 October. The last of the trio was delivered by air from Brize Norton (like the first two) on 19 May 1976.

Some reports suggest that the Qatari Mk 2As were upgraded to Commando Mk 3 standards during 1990-1992. The aircraft are operated by No. 9 Multi-Role Squadron, which also operates the Mk 2C VIP transport from Doha.

Qatar is one of the most enthusiastic Sea King operators, and was one of the first customers for the Commando variant.



Commando Mk 2B (Sea King Mk 72)

Two aircraft were delivered to Egypt specially fitted out for the VIP transport role. These were designated Commando Mk 2B but retained the same Sea King Mk 72 designation as the Commando Mk 2s which accompanied them, and upon which they were closely based. The aircraft differed externally in having an extra pair of cabin windows on the starboard side (giving a row of four windows) and with a single additional window to port. Internally, the plush cabin was well appointed and well

soundproofed. A VHF/FM radio telephone is provided, entirely separate to the helicopter's own communications equipment. The optional cabin air conditioning is believed to have been selected by all Commando VIP customers, a useful addition for Middle Eastern nations. The standard internal configuration included a conventional central aisle, with pairs of facing seats (aft- and forward-facing, on each side of a table) each side at the front and back of the cabin. These were divided

by a pair of inward-facing seats to port, with a table opposite them to starboard. Alternative configurations included two pairs of fore/aft seats and tables, with two inward-facing three-seat divans. These could be arranged symmetrically, with both fore-and-aft pairs at the front of the cabin, or with a three-seat divan facing each pair of fore and aft seats, one forward, one aft.

Forward of the main cabin is a small compartment with a tip-up seat for an attendant or steward, with accommodation

for another steward aft. The aft compartment also incorporates a small galley with storage for up to 50 lb (22 kg) of provisions for light meals or refreshments, and a well-appointed toilet. Another separate sub-compartment at the rear is the baggage hold.

One of the two aircraft was delivered in the same colour scheme as the utility Commandos, with desert sand topsides and light grey undersides, while the other wore a smart dark green and white VIP colour scheme. The first Mk 2B flew on 13 March 1975 and was delivered on 19 August. The second was delivered on 3 June 1976.

Commando Mk 2C (Sea King Mk 92)

Commando Mk 2C (Sea King Mk 92)

Seen with and without sand filters fitted



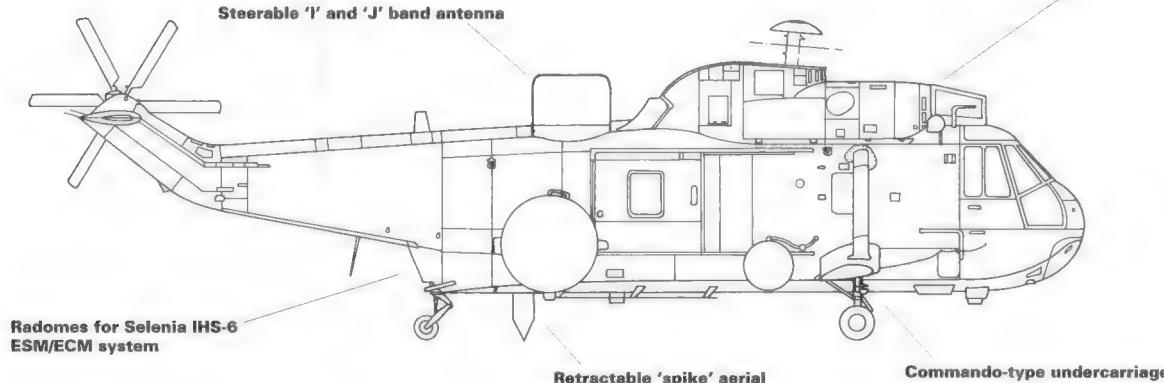
Commando Mk 2E (Sea King Mk 73)

The Commando Mk 2E is a dedicated autonomous electronic warfare platform, equipped with the Italian Selenia/Elettronica IHS-6 integrated ESM/ECM system, which has also been fitted to some Italian army Agusta 109s. Four were built for Egypt following a 1978 order. The designation Commando Mk 2D (Sea King Mk 80?) was

not used because it had been applied to a proposed version for Indonesia, leaving the appropriate E suffix for the first EW version of the Sea King family. The first Mk 2E made its maiden flight on 1 September 1978 but was retained in the UK for trials (some taking place at Aberporth test range) until 9 December 1980. The other three

aircraft were delivered on 3 April 1980. The IHS-6 integrates the RQH-5 ESM system which detects, locates and identifies hostile emissions in the 1-18 GHz frequency range, and the TQN-2 modular jamming system. It incorporates a 'wide open' instantaneous frequency measuring (IFM) antenna for monopulse direction finding (DF). The

Commando Mk 2E (Sea King Mk 73)

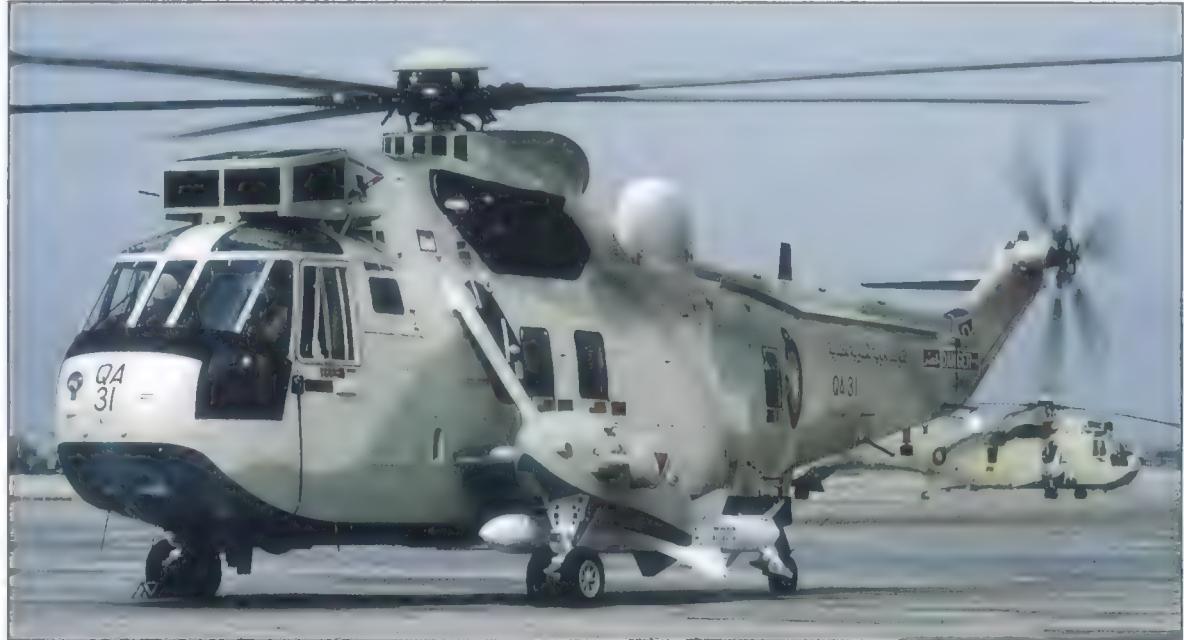


Commando Mk 3 (Sea King Mk 74)

Despite its Commando designation, the final Qatari aircraft are externally almost indistinguishable from Sea Kings, since they have undercarriage sponsons housing a retractable undercarriage and a dorsal radome, as well as a folding tail rotor pylon. The undercarriage sponsons are not quite standard, however, since they do not have provision for flotation bags. Instead, the aircraft must have the disc-like Commando flotation gear attached to the outer faces of the sponsons. Like the Commando 2 series, the aircraft retained a single extra window at the rear of the stretched cabin, on the port side. This was of the domed, 'bubble' type for improved all-round visibility. With their Gnome H.1400-1T engines and composite main rotor blades the Mk 3s could almost qualify as Advanced Sea Kings, although they lack the new five-bladed composite tail rotor. Thanks to the increased engine power, the Commando Mk 3 can operate in the hot conditions of the Gulf at an all-up weight of 9750 kg (21,500 lb).

The Commando Mk 3 was intended to perform utility duties and also to operate in the ASV role. The aircraft are Exocet compatible, but can carry a range of other weapons, including 16 SURA rockets, 18 SNEB rockets or a pair of podded 50-calibre machine-guns. Exocet seems to be the standard weapon, however, and is carried routinely. Apart from Qatar's Mirage F1s, the Commando Mk 3s represent the nation's most powerful anti-surface vessel strike asset, with the potential to ward off any threat to the Emirate from the sea. With two Exocets, the Mk 3 can almost reach the straits of Hormuz to the south-east or close to the head of the Gulf. The presence of Exocet-armed helicopters in this region is highly significant, as Exocet was used with great success by Iraq during the 'war of the tankers' with Iran.

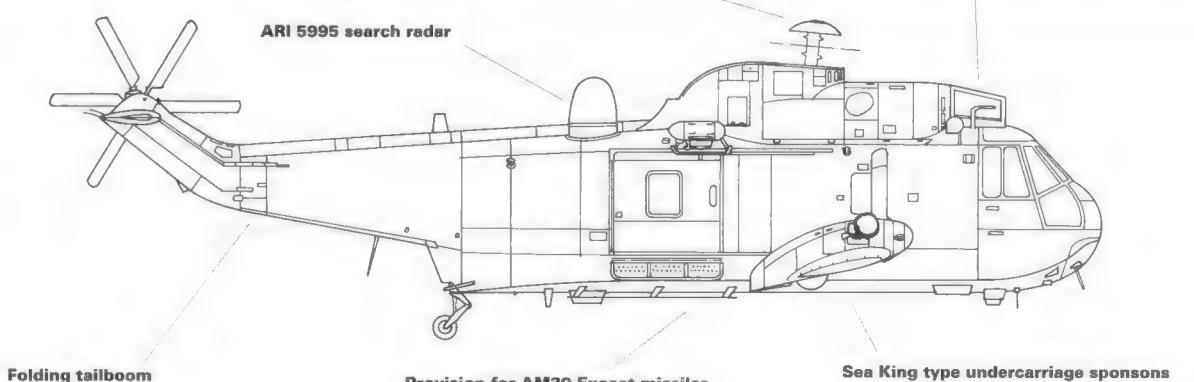
The first Commando Mk 3 flew on 14 June 1982, and was delivered on 26 November 1982. Delivery of the complete batch of eight aircraft (by Short Belfast from Stansted) was completed by 4 January 1984. The aircraft were delivered in a pale, more muted desert camouflage scheme than the utility Mk 2As which preceded them. They serve with No. 8 (ASV) Sqd augmenting the Qatari navy's fleet of patrol boats and fast attack craft. No. 8 Sqd partners No. 9 (with the other Commandos) as part of No. 2 (Rotary) Wing at Doha. The squadron mainly operates in the coastal surveillance mission. The aircraft are also fitted with a winch for SAR missions. During 1993 there were reports that Qatar was considering an upgrade for its Commando Mk 3s, but the status of this is uncertain. The upgrade was



to have included installation of a new radar (probably the Thorn EMI Super Searcher) and new INS, GPS and ILS. Composite main rotor blades would also have been fitted, giving reduced vibration levels.

Qatar's Commando Mk 3s are unusual in having a radar, Sea King-style sponsons and provision for launching Exocet missiles. There may be more than the original batch of Mk 3s in existence, as there have been reports of Qatar upgrading its Mk 2As to the later standard in the early 1990s.

Commando Mk 3 (Sea King Mk 74)



Whiteman AFB



Total Force in Operation



Guarding the gate at Whiteman is this B-52D, although the 'BUFF' never served at the base. Established as Sedalia Glider Base in 1942, the field was renamed in honour of 2Lt George Whiteman in October 1955. By that time SAC's 340th BW was in residence, flying the B-47 and KC-97. The wing left in 1963, its place taken by the 351st Strategic Missile Wing which was established at Whiteman to operate Minuteman ICBMs. As the 351st Missile Group, the unit is still based at Whiteman, although it is scheduled for deactivation in FY97.

personnel without degrading the force's capabilities. Rotating the available forces in and out of high-threat areas ensures that fresh troops and equipment will always be on hand and that fatigue, weariness and the stress common to overseas deployments are kept in check.

Deny Flight over Bosnia has provided a textbook example of how active-duty wings and squadrons operate in concert with each other and alongside their Air Force Reserve (AFRes) and Air National Guard (ANG) counterparts. AFRes and ANG crews have routinely flown missions over Bosnia as well as provided considerable tanker and logistics support to the region.

While the Total Force concept is easy to envision at Aviano, Italy, where AFRes A-10s can be seen taxiing in line with active-duty F-16s and F-15s and, once airborne, they all rendezvous with ANG tankers en route to Bosnian airspace, examples of the Total Force concept are not so easily identified in the States.

Whiteman Air Force Base, Missouri, has emerged as a good example of the new concept at work on a day-to-day basis. While Whiteman AFB is more widely known as the home of the first operational B-2 wing in the Air Force, it is also home of the Air Force Reserve's 442nd Fighter Wing and, for a limited time at least, the Kansas Air National Guard's 190th Air Refueling Group. The latter is temporarily based at Whiteman pending the completion of runway repairs at their home base at Forbes Field, Kansas. AFRes A-10s and the ANG KC-135Es share ramp space, work the same MOAs (Military Operating Areas) as the B-2 and, in the case of the tankers, provide

With budget restraints making their impact among the US military services, the Air Force leadership in general and Air Combat Command in particular is implementing a far reaching concept known as Total Force. Total Force is designed to keep America's Air Force at its highest level of readiness in meeting commitments throughout the world on a sustained basis without overworking or overextending any one command or individual unit. To share the workload, Air Combat Command's new commander, General Joseph Ralston, has initiated Total Force, whereby units from the active-duty Air Force are tasked to work trouble spots anywhere in the world and are augmented and supported by units from the Air Force Reserve and Air National Guard.

Long-term and ongoing operations such as Deny Flight over Bosnia and Southern Watch in the Persian Gulf region require that combat-ready units be on alert and ready to respond decisively to any threat anywhere in the world. Since the whole business of military might is a people business, every effort is being taken by US military commands to ensure sustained peak performance from equipment and

Level: Whiteman's best-known residents are the B-2s of the 509th Bomb Wing. A major reconstruction programme at the base heralded the arrival of the Northrop bomber, an effort which is ongoing to complete the 16 individual hangars for the operational B-2 force.

Below: The 442nd Fighter Wing was based at Richards-Gebaur AFB close to Kansas City (hence the 'KC' tailcode) until 1994, when it moved into Whiteman. The wing's 303rd Fighter Squadron operates a mix of attack-tasked A-10As and control-dedicated OA-10As.





Normally based at Forbes Field near Topeka, the 117th Air Refueling Squadron of the Kansas ANG spent much of 1995 at Whiteman while its own facilities were being renovated. The unit's KC-135Es are often employed on training duties with the B-2 force, which requires a large refuelling training effort. The squadron's nickname is the 'Kansas Coyotes', and the canine creature figures prominently in the nose art (left) and flightsuit patches.

refuelling assets for crews transitioning to the B-2 Spirit.

Refuelling the new bomber is no easy task and requires considerable skill not only from the B-2 crew but tanker crew as well. Since the B-2 is practically all leading edge there is con-

siderable bow-wave (air pushed up over the wing as the aircraft flies). Boom operators have likened the bow wave of the B-2 to that of the massive C-5. As the B-2 approaches the tanker the invisible wall of air literally pushes the tail of the tanker upward and forward several feet. Anticipating this phenomena results in a smooth contact between the tanker's boom and the B-2's refuelling receptacle. However, for tanker crews new to the B-2's unique configuration, the experience can be exciting as the tanker's tail is pushed up, forcing the trim tab wheel to madly spin as the aircraft tries to keep itself on a straight and level course. On occasion the autopilot is overloaded altogether.

Since a considerable amount of the transition training on the B-2 includes aerial refuelling, having tankers co-located on base is a luxury few other bomber units in the US enjoy. In addition to its duties flying in support of the B-2s, the 190th ARG also maintains its commitments throughout the world in both the European and Pacific theatres.

B-2 fleet

In 1995 there were eight B-2s permanently assigned to the 509th BW, the eventual total of operational aircraft being slated at 16 with four more assigned to training or in rework. As new aircraft become operational, earlier Block aircraft will be returned to Palmdale where they will be updated to the latest configuration. Based at Whiteman in 1995 were the following B-2s: aircraft 88-0329 'Spirit of Missouri', 88-0330 'Spirit of California', 88-0328 'Spirit of Texas', 89-0332 'Spirit of Washington',

'Spirit of California' was the second B-2 to be delivered to the 509th Bomb Wing. The wing was reformed at Whiteman on 1 April 1993 to prepare for B-2 operations, the first aircraft arriving on 17 December, the 90th anniversary of the Wright brothers' first flight.

Whiteman AFB



Left: 89-0127 'Spirit of Kansas' was Whiteman's sixth B-2. With eight aircraft now delivered the 509th Bomb Wing can complete the IOC of the 393rd Bomb Squadron. Further deliveries will allow the establishment of the 715th Bomb Squadron. Of the total force of 20 aircraft, eight will be assigned to each squadron with the remaining four in either training configuration or undergoing rework, including update of earlier machines to full Block 30 standard.

Right: Another view of 'Spirit of Kansas' taxiing at Whiteman. Readily apparent are the pop-up auxiliary air intakes above the main inlets, and the large dielectric panels for the main attack radar system either side of the nose. Behind each panel is a fixed antenna array for the Hughes APG-181 radar, the panels being angled outwards and downwards to avoid presenting a reflective spike back to ground sensors.

Below: Currently the B-2s of the 393rd BS are cleared to carry B83 nuclear bombs and Mk 84 conventional weapons. Clearance work is being undertaken to add the B61 and more conventional weapons, including GPS-aided munitions.



Whiteman AFB



Proudly wearing the 'KC Hawgs' patch, a 303rd FS pilot prepares for a training mission. Although considered quite roomy for normal missions, the cockpit of the A-10 gets cramped during long overwater deployments.

88-0331 'Spirit of South Carolina', 89-0127 'Spirit of Kansas', and 89-0128 'Spirit of Nebraska'. 89-0129 arrived in November 1995.

Located at the north end of the base in temporary buildings until permanent facilities are completed, the Air Force Reserve's 442nd

Fighter Wing quietly goes about its business. The 442nd FW has just returned from its third deployment to Aviano Air Base, Italy, where its pilots flew more than 350 close air support and forward air control missions over Bosnia. The fact that the wing was able to deploy rapidly in



Ground troops practise rapid turnarounds using the A-10's automatic ammunition loading system. Such training became vital during the squadron's deployment to the war zone of Bosnia.

force and sustain a presence in Italy is even more remarkable considering that many Air Force Reserve personnel must take time off from their civilian jobs in order to fulfil their active-duty commitments. Their training and preparedness is no less involved than their





active-duty counterparts and, in many cases, the level of experience in the Air Force Reserve ranks far exceeds that of the active-duty rosters.

In preparation for the most recent deployment to Italy, the 442nd FW pilots began their training about six months before the wing left for the theatre. Each pilot had to fly at least two sorties in a 'Bosnia scenario' within a month of leaving. The day-to-day scenarios emphasised co-ordination with outside agencies (ground FACs, NAEW, and ABCCC) as well as simulating the same types of weapons they knew they would be tasked to use. The aircraft maintainers had to manage the aircraft inspection schedules to assure that the most serviceable airplanes would be ready for the trip to Italy, especially since they would be flown almost round the clock once in theatre. The munitions people trained on weekends, loading bullets and practising quick-turn loads of weapons.

Aviano deployment

On 13 April 1995, an air armada including 12 A-10s (six each from the 303rd Fighter Squadron from Whiteman and the 47th Fighter Squadron from Barksdale AFB, Louisiana), two KC-10s (one each from McGuire AFB, New Jersey and March AFB, California), one C-141 from Wright-Patterson AFB, Ohio and one C-5A from Dover AFB, Delaware, departed for Aviano, Italy.

There was a minimum of two and usually three inflight refuellings on the transoceanic flight. The first one took place about an hour after take-off to allow aircraft to return to their take-off base if they could not receive fuel. The refuellings were planned so that pilots always had enough fuel to divert to an airbase in the

event of some unforeseen problem or equipment malfunction. The A-10s were assigned six to a tanker with three flying on each side of the tanker in echelon formation, the spacing depending on visibility.

Once in Italy, the 442nd FW pilots were involved in two-ship missions over Bosnia. At least one of the aircraft was configured for the FAC mission while the other carried a more standard fighter-bomber load. That way they could be employed strictly as fighters or in the air FAC role as required. The A-10s worked with United Nations ground-based forward air controllers on just about every mission and did practice attacks on simulated targets chosen by the ground FACs.

After take-off, the pilots would talk to the NATO Airborne Early Warning aircraft to verify their IFF systems were working, then check weapons systems to make sure they were operational and, finally, confirm that their ECM systems were working. The pilots would then contact the Airborne Command, Control, and Communications (ABCCC) aircraft and receive mission tasking. By that time the A-10s were ready to rendezvous with a tanker and top off the fuel tanks prior to entering Bosnia. After refuelling, the A-10 pilots entered Bosnia en route to their assigned areas, contacted ground FAC, received target briefings, and executed their simulated attacks. This procedure contin-

These 'KC Hawgs' display a likely combat load for Bosnia-style operations, albeit using training rounds rather than live munitions. Defensive stores include twin AIM-9s on the port outer pylon and ALQ-131 ECM pod on the starboard outer, while offensive stores comprise two AGM-65 Mavericks, two TERs loaded with Mk 82 AIR bombs and pods of 2.75-in rockets for target marking. An unusual feature of the A-10 highlighted by the current Compass Ghost grey scheme is the brown stain on the underside of the port engine nacelle caused by the exhaust from the APU in the rear fuselage.

ued until the A-10s reached bingo fuel and left Bosnia for a direct flight back to Italy. The typical sortie lasted about three and a half hours.

Flights over Bosnia were not without their tense moments as several 442nd FW pilots were shot at on numerous occasions. Anti-aircraft artillery sites were active and, more than once, an SA-7 anti-aircraft missile was launched at the low-flying A-10s. Despite flying over 300 missions, all aircraft returned undamaged.

The Whiteman- and Barksdale-based A-10s completed their deployment and returned home, being replaced in Aviano by the 510th Fighter Squadron of the 52nd FW from Spangdahlem. The 442nd FW arrived back at Whiteman to very little fanfare, having done their job in Italy, and quietly slipped back into the continuing training in preparation for their next 'real world' assignment.

Randy Jolly



Left: With the Total Force concept, reservist units such as the 303rd FS can expect to see more action than previously. Their efforts are very important in long-term policing efforts such as those over Bosnia or Iraq, where the reservist units can allow heavily committed active-duty units to stand down for rest periods.

Right: Under the Companion Trainer Program, the 509th Bomb Wing has a number of Northrop T-38s assigned to provide low-cost flight hours for B-2 aircrew.

Czech and Slovak Republics

Ceské Letectvo a Protivzdušná Obrana (Czech Air Force and Air Defence Force)

Czechoslovakia had a military aviation tradition stretching back to 1918, after the new nation declared its independence from the Austro-Hungarian Empire. Following that, it saw world war and Soviet occupation. Once a cornerstone of the Warsaw Pact, the fall of the old Soviet bloc opened the way for the Czechoslovak people to choose their own destiny. As a result, the Czech Republic split from its Slovak neighbour to seek its new place in Europe.

The post-war re-establishment of Czechoslovakia included restoration of its former territories, apart from the transfer of Subcarpathian Ruthenia to the USSR, and the formation of new national defence forces, this time with a heterogeneous collection of surplus World War II equipment.

During the war, the Nazis had taken over the Czech aircraft industry to build a total of 4,147 aircraft of German design between 1941–1944. These were mostly trainers and support aircraft, including the Arado Ar 96B, Bücker Bü 131 Jungmann (as the Tatra T.131), and Bücker Bü 181 Bestmann, Fieseler Fi 156C Storch, Focke-Wulf Fw 189, and the Siebel Si 204 light twin. In 1944, production also started of the Messerschmitt Bf 109G and Me 262 jet-fighter, together with the Junkers Jumo 211F piston-engine and the Jumo 004B turbojet. No deliveries of these combat types had been achieved from Czechoslovakia by the time of the German withdrawal, although both later entered Czech service, redesignated as the Avia/Letov S-199/C.10/two-seat C.110 and Jumo 211F-engined C.210 series, and the Avia S.92 (on service trials only), respectively.

In Soviet hands

From mid-1945, the new Czechoslovakian air force (Ceskoslovenske Letectvo) initially operated all these types plus others taken over from the Luftwaffe, together with three ex-RAF Czech squadrons (Nos 310, 311 and 312) of Spitfires (later sold, with some of the Avia S-199s, to Israel), and some DH Mosquito FB.Mk 6s, Lavochkin La-5 and La-7 fighters and Petlyakov Pe-2 light bombers from the USSR. The air force was mainly organised on RAF lines, with many ex-RAF Czech officers in senior positions, including the Commander-in-Chief, until the Communist take-over following the elections of May 1948. Most ex-RAF personnel were then regarded as being 'politically impure' and were discharged in extensive purges. A complete reorganisation of the air force then ensued under Russian supervision.

Major expansion was initiated at the same time as an extensive programme of airfield construction. This eventually involved 22 major

military airfields with runways averaging 2200–2800 m (7,218–9,186 ft) in length, and 14 reserve bases, several of which were jointly civil-operated, with runways of up to 3550 m (11,647 ft). Equipment supplied from the USSR included Ilyushin Il-10 *Shтурмовик* ground-attack aircraft, plus Lisunov Li-2 (C-47) and Ilyushin Il-12 transports, followed by the first Soviet-built MiG-15 'Fagots' from 1951 after an evaluation batch of a dozen Yakovlev Yak-23 'Flora' (S.101) jet fighters. These were subsequently built under licence as the S.102 by Letov's Vodochody factory, with final totals of 815 completed between 1953–54, followed by 620 of the uprated MiG-15bis or S.102B in 1954–56, and no fewer than 1,970 two-seat MiG-15UTI 'Midget' (S.103) combat trainers by 1962, for 3,405 in all.

Aircraft production increased

While most of the Letov/Aero-built single-seat MiG-15s were used by the Czechs, some went to other Warsaw Pact countries, including Russia, which also received the majority of the trainer versions. The renamed (on 1 July 1954) Aero Vodochody factory went on to licence-build 103 MiG-19S 'Farmer' fighters, as S.105s, between 1958–63, and 195 MiG-21F-13 'Fishbeds' (S.107s) in 1962–1972, mainly for the Czech air force.

By the late 1950s, the air force was estimated by NATO to comprise five fighter regiments, each with three squadrons totalling 36 aircraft, equipped with MiG-15s, MiG-17 'Frescos' (S.104s) including MiG-17PF radar-equipped all-weather fighter versions, and MiG-19S/Ps (from 1958); three ground-attack regiments of Ilyushin Il-2s and Il-10s; and a light bomber regiment with twin-jet Ilyushin Il-28 'Beagles'. With an estimated strength of more than 600 aircraft, the Czechs operated the second largest of the Communist-controlled Warsaw Pact air arms (after the Polish air force), despite a national population of little more than 16 million people.

The Czech aircraft industry was allocated the production of advanced trainers for all the Warsaw Pact countries, apart from Poland, plus others in the Third World bloc. These programmes started in the 1950s with licensed

production at Avia's Kunovice factory in Moravia of the Shvetsov ASh-61 radial-engined Yak-11 and Yak-11U as the C.11 and nosewheel-gearred C.11U. Production of indigenous jet trainers then followed from the early 1960s, Aero Vodochody and Let Kunovice completing 1,943 and 1,625 L-29 Delfins by 1974, or no fewer than 3,568 in all, of which more than 3,000 were delivered to the Soviet Union.

These were followed by 2,780 of the higher-performance Ivchenko/Motorlet AI-25W turbofan-powered L-39 Albatros by the end of 1990, of which the USSR bought 2,082, and the Czech air force only 75. In addition to 42 L-39C basic/advanced trainers, Czech procurement in that period included eight L-39V single-seat target-towing versions in 1976, followed by 25 L-39ZA armed trainer/reconnaissance variants with four underwing weapons or sensor pylons and a ventral fuselage pod for a twin-barrelled 23-mm GSh-23-2 cannon.

Expansion in the 1970s

Modernisation of the Czech front-line squadrons undertaken from the late 1970s began with replacement of the MiG-15bis and MiG-17F in ground-attack squadrons by the variable-geometry MiG-23BN, and of MiG-19s in fighter units by MiG-23MF/MLs. Eight Czech pilots undertook initial conversion training with the Soviet air force (Voyenno Vozdushnye Sily – VVS) on MiG-23UBs at Frunze, in Kyrgyzstan, from August 1977, in anticipation of first deliveries of the MiG-23BN in January 1978. A total of 32 MiG-23BNs and four two-seat MiG-23UBs, accompanied by a range of precision-guided and conventional munitions (PGMs), eventually equipped two squadrons within 28 Air Combat Regiment (28 Bitevni Letecky Pluk – BLP) at Caslav by the end of 1983.

Similar conversions were undertaken for delivery of the Czech MiG-23 'Flogger' interceptors, equipped with a Sapfir-23D-Ch 'Jay Bird' fire-control radar and TP-23 IRST system, in association with Toropov R-3S/K-13A (AA-2 'Atoll'), Molniya R-60 (AA-8 'Aphid') and Vympel R-73E (AA-11 'Archer') air-to-air missiles. The first of about a dozen MiG-23MF 'Flogger-Es' began arriving at Bechyne in August 1978, before equipping a fighter squadron in 1 Fighter Air Regiment (1 SLP – Stihacich Letecky Pluk) at Budejovice/Plana, after extension of its runway. Follow-on deliveries of 17 upgraded MiG-23ML 'Flogger-Gs' allowed formation of a second MiG-23 squadron, in 11 SLP at Zatec; these aircraft featured a Soyuz/Katchaturov R-35F-300 instead of a Katchaturov R-29F-300 turbojet, and Vympel R-23R/T (AA-7 'Apex') medium-range semi active radar-homing or IR-homing AAM capability from revised fire-control systems. Some MiG-23MLs were also taken on by 1 SLP, each unit further receiving two or three two-seat MiG-23UB 'Flogger-Cs'.

Mi-24 deliveries

Deliveries also started to the Czech air force in August 1978 of Mil Mi-24 'Hind' attack helicopters to supplement earlier deliveries of piston-engined Mi-1 'Hares' and Mi-4 'Hounds', plus twin-turboshaft Mi-8s for a variety of transport, utility and assault roles. Training of



Although the MiG-29 'Fulcrum' was the most capable fighter available to the Czechoslovak air force following the demise of the Warsaw Pact, political considerations and serviceability problems caused the Czech air force to retire its aircraft after the country split in 1993.



The Czech air force retained all the MiG-23s when the former nations' air assets were divided. As a pure interceptor, the elderly MiG still has a relatively impressive top speed and rapid acceleration, and has been fitted with the MATRA Magic 2 missile in a trial installation.



This Czech air force MiG-23ML 'Flogger-G' appeared at Hradec Kralove in a very impressive grey tiger-stripe scheme. All the remaining MiG-23s are flown by 41 SLt at Caslav.



A more business-like camouflage is the standard colour scheme. Despite their tidy appearance, the MiG-23s are all nearing their maximum design life and need replacing.



When the Czech air force retired its MiG-23BNs and MiG-23MFs, it also retired the MiG-23UB two-seaters. Type conversion for the remaining MiG-23MFs is now handled by the remaining MiG-23UMs, based at Cáslav with 41 Stíhací Letka.



Preparing for a training mission from Malacky, this Su-25 is armed with a UV-32 rocket pod and FAB-250 free-fall bomb. The Su-25 can also use more sophisticated weaponry.



The Czech air force's Su-25Ks are among its most modern aircraft, and the ruggedness of the design ensures that it will continue in service for many years to come. The type makes up almost half of the dedicated attack strength since the MiG-23BNs of the CVL were retired.



Obviously appreciating the NATO designation 'Frogfoot', this Su-25 tail badge is a reminder of the very potent anti-tank capability of the aircraft's 30-mm cannon and missiles.

Air Power Analysis

Czech pilots, weapons systems operators and maintenance crews began at Frunze in June 1978, and the first four Mi-24D 'Hind-Ds' arrived at Prostejov on 24 August. An early version of the 'Hind', the Mi-24D is armed with 9M17P Falanga (AT-2 'Swatter') rail-launched anti-tank missiles, employing radio command to semi-automatic line-of-sight guidance from a swivelling Raduga F transmitter pod beneath the port forward fuselage. It also mounts a 9-A-642 12.7-mm (0.5-in) four-barrelled rotary machine-grenade launcher in its USPU-24 chin turret.

Some 28 Mi-24Ds and two dual-control Mi-24DU trainers with no gun armament were delivered to 51 Helicopter Regiment (51 Vrtulnikovy Pluk – VrP) at Prostejov, followed by 28 of the newer Mi-24V 'Hind-Es'. With uprated Klimov/Isotov TV3-117V turboshaft engines, the Mi-24V also had upgraded weapons systems, including 9M114 Shturm (AT-6 'Spiral') tube-launched ATMs which retain SACLOS guidance. Being supersonic, however, with a range of up to 5 km (2.7m), they also have an air-to-air capability for helicopter interception roles. In Czech service, the Mi-24Vs have been mainly operated by 11 Helicopter Regiment (11 VrP) from Plzen-Line.

Sukhoi Su-22 and Su-25

Early 1984 also saw the further and almost simultaneous re-equipment of several of 10 Air Army's tactical ground-attack units, with deliveries of new Sukhoi types. First to arrive in March of that year were the precursors of 56 swing-wing Su-22M 'Fitters' to replace a similar number of fixed-wing Sukhoi Su-7MB and BKLS delivered in the late 1960s. All but about a half-dozen of the new strike/attack aircraft were Su-22M-4 'Fitter-Ks' with Saturn/Lyul'ka AL-21F-3S turbojets, the remaining 10 comprising two-seat Su-22UM-3K 'Fitter-G' combat trainers. The Czech air force did not retire its last Su-7BKL until about mid-1989, and was one of the last users of the type.

Czechoslovakia's first 'Fitter-Ks' lacked TV missile-guidance systems and associated displays which, in later deliveries, allowed the wider use of PGMs. These eventually included Kh-25ML/MR (AS-10 'Karen') radio command-, laser- or TV-guided ASMs; Kh-58E (AS-11 'Kilter') anti-radar missiles; Kh-25MP (AS-12 'Kegler') ARMs; and Kh-29ML (AS-14 'Kedge') laser- or TV-homing hardened-target attack missiles, in addition to KAB-500 LGBs and conventional HE bombs.

An early Czech Su-22 recipient was 47 Reconnaissance Air Regiment (47 Prieskumne Letecky Pluk – PLP), which re-equipped a flight at Pardubice, alongside MiG-21R and L-29R units. Others went to three or four squadrons in 6 Air Combat Regiment (6 BLP) at Prerov, and 20 BLP at Namest. In 47 PLP service, the Su-22s carried a long KKR reconnaissance pod on the centreline of five lateral fuselage pylons, containing three optical cameras and flares for night operation in the forward section, and Elint modules behind. An SPS ECM pod was also normally carried beneath the port inner of six underwing pylons.

On 2 April 1984, a Soviet pilot delivered the first of 36 Su-25K 'Frogfoot-A' close-support aircraft and two two-seat Su-25UBK 'Frogfoot-B' combat trainers to equip three squadrons of 30 BLP at Hradec Kralove (transferred to Pardubice

in 1985). Prior to receiving Su-25s, this unit had operated most of the 25 L-39ZA light ground-attack versions of the Albatros delivered from Aero between 1973-1990. Powered by two Soyuz/Tumanskii R-95Sh non-afterburning turbojets, the Su-25K (*komierchieski*/commercial) and UBK were newly-developed export versions of 'Frogfoot'. Czechoslovakia was the first foreign customer for these aircraft, although Iraq followed closely. Sukhoi Su-25K armament included a similar range of weapons to the Su-22's, up to 4000 kg (8,818 lb) of weapons and PGMs on 10 underwing pylons plus a belly-mounted 30-mm AO-17A twin-barrelled cannon.

Joining the MiG-29 club

Further MiG-21 replacements came in late 1989 with the arrival of the first MiG-29 'Fulcrum' advanced air superiority aircraft. These comprised 18 single-seat and two MiG-29UB 'Fulcrum-B' combat trainer versions delivered to two squadrons of the 11 SLP at Zatec, near Czechoslovakia's western borders. This followed initial conversion of 15 Czech pilots in the USSR at Frunze and elsewhere. The MiG-29s added the Vympel R-27RE/TE (AA-10 'Alamo-A/B') semi-active radar homing AAMs with a BVR interception capability to the Czech inventory of AA-2s, AA-8s and AA-11s, although their Phazotron NO-19A 'Slot Back' radars have only a single-target engagement ability.

The MiG-29s' armament also includes an integral 30-mm GSh-30-1 lightweight and highly accurate cannon in the port wingroot, plus a full range of ground-attack weapons on six underwing pylons. A similar follow-up batch of MiG-29s had originally been planned but, within a few months of the initial deliveries, during a visit to Moscow in February 1990, Defence Minister Miroslav Vacek announced that further procurement would be abandoned as part of 10 per cent cuts in that year's defence budget.

Soviet forces in Czechoslovakia

All Czechoslovakian armed forces were originally under direct Soviet command, following the conclusion of the Status of Forces agreement. This was a result of the August 1968 invasion by troops and armour of the USSR to end the Czech government's Prague Spring liberalisation policies. Some 80,000 troops with supporting units within the Central Group of Soviet Forces of the Southwest Military Operations Theatre (Teatr Vojennykh Deystvii – TVD) were also stationed in Czechoslovakia, with HQ at Milovice.

The resident Soviet forces eventually included about 140 combat aircraft, comprising an interceptor regiment with 45 MiG-23MF 'Flogger-Es', five two-seat MiG-23UB 'Flogger-Cs' and 10 MiG-29 'Fulcrums' at Milovice; a nuclear-strike regiment of 25 or 26 MiG-23BN/UB 'Flogger-F/Cs' and 30 MiG-27K 'Flogger-Hs' at Mimon; and a strike/ground-attack regiment at Sliac equipped with 14 Su-17M-3/Su-22UM-3 'Fitter-H/Gs'.

A further 139 Mi-24D/V 'Hind-D/Fs' and 87 Mil Mi-8 'Hip-C/D/E/K' armed helicopters served five mixed regiments at Milovice, Mimon, Oulmouc and Sliac-Zvolen (two). Some 30 support aircraft in a Milovice-based transport regiment included 13 Antonov An-12 'Cubs', three An-26 'Curls' and 11 Tupolev Tu-134

'Crustys', while four Ilyushin Il-28 'Beagles' were used for radar and ground-aid calibration from Sliac. Nuclear warheads for Russian and Czech strike aircraft, as well as for SS-21 'Scarab' and SS-23 'Spider' tactical ballistic missiles, were also stored locally.

With the late 1989 collapse of the Czech Communist government, the new liberal administration terminated participation of its national forces in Warsaw Pact exercises, and demanded a withdrawal of all Soviet forces by the end of 1990. At the same time, it deployed troops to protect its eastern as well as western borders, by regrouping its forces on a regional basis within three commands of approximately equal strength in Bohemia, Moravia and Slovakia.

These replaced two former HQs controlling eight divisions based in Bohemia-Moravia in the west, and two divisions in the eastern province of Slovakia. The last Russian forces then left Czechoslovakia by June 1991, although the last VVS air unit, comprising 24 MiG-23MFs and 10 MiG-29s of the 114th Fighter Aviation Regiment, had flown out of Milovice for Ivano-Franka in Ukraine on 21 January 1991.

Prague's major defence reappraisal also included the start of substantial cuts in the annual military budgets, and reductions in armed forces personnel from previous totals of 172,000, including 51,000 in the air force. Before the dramatic events of 1989, the Czechoslovak Army Air Force was officially stated to have 407 fixed-wing combat aircraft (including 137 strike/attack types), and 101 combat helicopters, as well as nearly 50 utility transports, operating from 12 bases.

One of the first moves of the new democratic Czech government was the scrapping of 51 of its older MiG-21F-13s, MiG-21PF/PFM and MiG-21Us from 7th Air Army units. Apart from economy, this move was directed towards meeting Czech commitments to the Conventional Forces in Europe (CFE) treaty limits, which stipulate 345 combat aircraft and 75 attack helicopters. For economic reasons, further reductions were also planned, to new totals of no more than 270 combat aircraft and 56 armed helicopters by 1993.

1990 Order of Battle

At that stage, not surprisingly, the air force in 1990 – then known as the Ceskoslovenske Vojenske Letectvo (CVL) – was organised very much along Soviet lines, with two air armies. With main responsibility for Czech air defence, the 7th Air Army (HQ Prague) comprised two air divisions (Letecky Divize) with eight squadrons (Letky) in three regional fighter regiments (Stihacich Letecky Pluky – SLP), and six air defence missile regiments (Protiletadlov Rakety Pluky – PRP). Normal regiment strength was two or three (or, exceptionally, four) squadrons, with nominal establishments of 12-18 aircraft, plus two or more dual-control versions of operational types. Each regiment also had an allocation of two-seat Aero L-29 Delfin or L-39 Albatros jet trainers for continuation, communications and instrument flying.

Composition of the 7th Air Army, with HQ at Stara Boleslav near Prague, comprised at that time the 2nd Air Defence Division's 8 SLP (regiment) at Brno, with 30 MiG-21PF/PFM 'Fishbed-D/Fs' and three two-seat MiG-21UM 'Mongol-Bs', plus the 3rd Air Defence Division's 1 SLP, Ceske Budejovice, operating 32 MiG-21PF/PFMs, 10



The Sukhoi Su-22M4 is a very potent attack asset, capable of delivering command-guided, anti-radiation and TV-guided munitions, as well as unguided rockets and 'iron' bombs.



Pictured in the days before partition, this Su-22M4 stands in front of its protective Soviet-style hardened aircraft shelter. The type was, and is, highly rated by its pilots. The M4 in particular had a high standard of equipment, including powerful ECM pods and navigation avionics.



Su-22UM-3s of 321 TPzLt serve as conversion trainers for the unit's single-seat Su-22M4s. This aircraft has defensive flare dispensers fitted in a slim fairing just below the fin root.



This Su-25UT is the only example of this variant flown by the Czech air force, alongside the Su-25Ks of 322 TLt at Namest. The unusual wingtip airbrakes are prominent in this photograph, as is the heavily armoured construction of the forward fuselage area.



The future of the venerable MiG-21 seems less secure than before, due to the strong pressure to buy second hand Lockheed F-16A/Bs in preference to a MiG-21 upgrade.



Despite its cartoon-style paint scheme, the MiG-21 is anything but a 'Mickey Mouse' aircraft, and the 'UM' variant remains in service with 42 SLt, 43 SLt and LZSc 1. The older MiG-21s have been retired to save funds and stay within the CFE treaty limitations.



This L-39ZA, formerly based at Zatec with 1 Letka, is now based at Caslav following the closure of the former base. These light trainers retain a secondary attack capability.



This L-39ZA, probably belonging to the former CVL's 1 Letka, is decorated with tiger nose badge and tail stripes plus an albatross on the intake, and is armed with a 23-mm gun pod.



The Mi-8 remains in service despite the air force taking delivery of larger numbers of Mi-17s. This aircraft was flown by 3 DLP, a mixed transport regiment which also operated various fixed-wing types including L-410s, An-24RVs, a Tu-134 and two Tu-154Bs before partition.



This Mi-24 'Hind-D' of 331 VRLT based at Prerov appears resplendent in this vivid 'tiger' paint scheme. Red ASO-2V chaff and flare dispensers are fitted under the tail boom.

Air Power Analysis

MiG-21UMs, 18 MiG-23MF 'Flogger-Es' and three two-seat MiG-23UB 'Flogger-Cs'. At Zatec, 11 SLP in the same Air Defence Division was equipped with 18 MiG-21PFs and three MiG-21UMs, which were replaced by 18 MiG-29 'Fulcrum-As' and two two-seat MiG-29UB 'Fulcrum-B' trainers. It also had 12 of the later MiG-21MF 'Fishbed-Js', as well as 17 MiG-23MFs and two MiG-23UBs. Another two air defence missile divisions with six SAM regiments operated 250 V-75 Dvina/SA-2 'Guideline', S-125 Neva/SA-3 'Goa' and S-200 Volga/SA-5 'Gammon' launchers from 40 sites, supplemented from 1989 by shorter-range SA-11 'Gadfly' SAMs.

The 10th Air Army

Czechoslovakia's 10th Air Army (HQ, Hradec Kralove), with up to 16 ground attack, and combined fighter-bomber/reconnaissance squadrons (Stihacie-Bombardirovacich Letecky Letky) in six air combat regiments (Bitevni Letecky Pluky – BLP) and two air divisions was Czechoslovakia's tactical air arm. From 1968, it came under control of the Soviet Army's TVD Southwest within the Central Group of Forces, and also included a large transport and helicopter support force. A direct-reporting aircrew training school and military academy was at Kosice, in eastern Slovakia.

Organisation of the 10th Air Army then comprised 5 BLP at Dobrany-Line, with 38 dual-role MiG-21MF, and 10 MiG-21UMs in an OCU; 6 BLP at Prerov, with 39 MiG-21MFs and three MiG-21UMs, converting to Su-22M-4 'Fitter-Ks'; 9 BLP at Bechyne, with 52 MiG-21PFs, 17 MiG-21MFs and eight MiG-21UM trainers; 20 BLP at Namest nad Oslavou, with 35 Sukhoi Su-22M-4 'Fitter-Ks' and three Su-22UM-3K 'Fitter-Gs'; 28 BLP at Caslav, with 31 MiG-23BN 'Flogger-F' strike interceptors and five two-seat MiG-23UBs; 30 BLP 'Ostravsky' at Pardubice, with 35 MiG-21MFs and MiG-21UMs, plus 36 Sukhoi Su-25K and two two-seat Su-25UBK 'Frogfoot-A/Bs'. At Hradec Kralove, 47 Reconnaissance Air Regiment (47 PLP) operated 45 Su-22M-4s, supplementing 20 MiG-21R 'Fishbed-Hs' and a few camera-carrying L-29R trainers, and two Tu-134s and some Mi-8PP 'Hip-Ks' with additional ECM/Elint taskings. At Ostrava-Mosnov was 1 Transport Air Regiment (1 Dopravní Letecky Pluky – DLP) with 15 Antonov An-2 'Colt' biplanes, two four-turboprop An-12BP 'Cubs', six twin-turboprop An-24RV 'Cokes', six An-26 'Curls' and 12 Let L-410M/UVPs, plus a Tu-134A, three Tu-154B-2 'Careless' and five Yak-40 'Codlings' for government use.

Helicopter force

There appeared to have been some overlap between Czech air force and army helicopter operation in four regiments of Army Aviation (Pozemni Vojsko – PV) within the 10th Air Army. These comprised 11 Helicopter Regiment (11 Vrtulnikovy Pluk – VrP) at Plzen-Bory with an HQ company of eight Mil Mi-2 'Hoplites' from 52 acquired; all 30 Mi-24V 'Hind-E' gunships in two squadrons; and 12 assault-equipped Mi-17 'Hip-Hs', delivered around 1987. At Prostejov, 51 VrP operated 24 Mi-2s, 10 Mi-8T/Mi-17 'Hip-C/Hs', two Mi-8 'Hip-Ds', 24 Mi-24Ds and two Mi-24DUs, also

in support of the 1st Army. 31 VrP was equipped with eight Mi-8PPA/Mi-17PP 'Hip-Ks' and an Mi-9 'Hip-G' at Bechyne for airborne command station, ECM and communications roles, in conjunction with a few Mi-2s, eight Mi-8Ts, an Mi-9 and two ECM Mi-8PP 'Hip-Ks' of 52 VrP from Havlickuv-Brod, for the 4th Army.

Although sharing a common NATO ASCC codename, the PV's Mi-8PPA and Mi-17PP 'Hip-K' ECM helicopters differ considerably more than from the relatively minor changes related to the latter's export designation, characterised by the tail rotor being on the port instead of the starboard side of the rear fin. For its communications monitoring and jamming roles, the Mi-8PPA has two rows of three large cruciform dipole antennas on each side of its rear fuselage fairing, or alternative segmented planar arrays, plus a slab-sided container beneath each jetpipe.

The Mi-17PP's ECM equipment, however, is installed on two large and vertically-mounted cylindrical containers flanking the rear fuselage sides, behind what appears to be a long tubular cooling duct with a forward intake. 'Hip' transport helicopters were used alongside the 'Hinds' for troop deployment and resupply. The Mi-2 light helicopters undertook liaison, general communications and limited air observation roles.

Pilot training

By 1990, the Czech Military Institute of Aviation, or Air Academy (Vysoka Vojenska Letecka Skola Slovenskoho Narodniho Povstani – VVLSSNP), which was also designated 2 Training Regiment (2 Letecky Skolni Pluk – LSP), was based at Kosice. The Institute operated 27 L-39Cs in a four-year wings course that totalled 280 hours and followed from 30–50 hours of primary training on Zlin 42 lightplanes with the paramilitary Organisation for Co-operation with the Army (SVAZARM). Fast-jet pilots then underwent type conversion on 27 MiG-21PFM/MFs and 17 two-seat MiG-21US/UMs of 1 Training Regiment (1 LSP) at Prerov.

After weapons and tactical training on the MiG-21MFs of 5 BLP at Dobrany to become a 3rd-class pilot, a further four to eight years with a front-line unit was needed for a 1st-class rating, and all-weather combat participation. Remarkably, Kosice still operated 36 Mi-1 'Hares' for basic helicopter training, students then passing to 3 Training Regiment 'M.R. Stefanika' (3 LSP) at Piestany. There, another 24 Mi-1s and six twin-turbine Mi-2s, alongside 30 Aero L-29s and four Let L-410s, were used for advanced helicopter and transport instruction to wings standard.

Other direct-reporting units at that time included the Aerial Photo Mapping Group (Fotolecteka Skupina – FLS) at Hradec Kralove. Its establishment included an extensively modified Ilyushin Il-14 twin-engined transport, with ventral camera hatches and an extended and bulbous glazed nose serving as a navigational, observation and camera sighting position. Unlike most Czech air force Il-14s, which were licence-built by the Avia factory at Cakovice, the converted Il-14FG (*fotogrammetricka*), serialled 6102, was delivered from the USSR in standard transport form in July 1958. It was also the last Il-14 to remain in Czech air force service, being used on international Open Skies observation missions until its final retirement in April 1994. In the FLS, it was supplemented before that time

by seven camera-equipped twin-turboprop Let-410FGs and a single Antonov An-30 'Clank' acquired from Bulgaria in 1990.

Another independent unit was the Service Trials Centre (Vyzkumny Ustav 030) at Prague/Kbely, which undertook operational tests and clearance of all aircraft and equipment joining the Czech air force inventory.

The CVL changed dramatically after the peaceful revolution in November 1989 and the disbanding of the military structure of the Warsaw Pact organisation on 31 March 1991. No longer part of the Eastern Bloc, the Czech and Slovak Federal Republic (CSFR) evolved a new policy for its air force that concentrated on the protection of national assets and air defence.

The practical effect of this was a reorganisation and redeployment of assets and a reduction in the number of personnel and aircraft operated. This meant scrapping the old Soviet-style structure and a gradual transition towards a West European organisation. Inevitably, a very difficult economic situation meant strong competition for dwindling resources and a slower rate of change than the air force would have liked. By the time of the next major upheaval – the separation of the two republics – the reorganisation was still very much in transition.

Under the previous regime, the CSAF faced NATO in the West with the main concentration of air defence bases in that part of Czechoslovakia, with a few airfields in East Slovakia, used mainly for training. It was clear that there was an urgent need to redeploy some of the front-line units further east to spread air force units more evenly across the whole of the country, and face other possible territorial threats. These redeployments had to be combined with reductions in the size of the Czech and Slovak air force, with the closure of bases and retirement of some of the older aircraft types.

This resulted in the disbandment of several regiments, starting with MiG-21 units 4 BLP at Pardubice and 5 BLP at Plzen. This was followed later in 1993 by 9 SBoLP at Bechyne, and also included 6 SBoLP at Prerov and 47 PLP at Kralove, whose Su-22M-4s were transferred to 20 SBoLP at Namest. The MiG-21Rs of 47 PLP were moved briefly to Caslav, before all 'Fishbed' operations were centred on Prerov. More than 70 older Czech MiG-21s had been placed in open storage with Aero Vodochody by late 1991.

Pre-partition air force deployments

Within the Fighter Force of Air Defence (Stihacie Letectvo Protivzdušnej Obrany Statu – PVOS) administered from Stara Boleslav were the 2nd and 3rd Air Defence Divisions (2/3 Divize), with HQ at Brno and Zatec, respectively. In the 2nd ADD, two squadrons from the former 8 SLP were renumbered as 81 Independent Fighter Squadron 'SNP' (81 Samostatna Stihacia Letka – SSLT), flying MiG-21MFs from Zvolen-Sliac, and 82 SSLT, again with MiG-21MFs, at Ostrava-Mosnov. The larger 3rd Air Defence Division included 1 Fighter Regiment 'Zvolensky' (1 SLP) operating MiG-23MF/MLs from Ceske Budejovice and the Zatec-based 11 Fighter Regiment 'Invazni' (11 SLP) with a squadron each of 18 MiG-21MF/PFMs and six MiG-21UM/US, plus the MiG-29s.

The largest part of the CSAF, the Tactical Air Force, was administered by the 34th Fighter-



Despite no longer operating in concert with Soviet forces in 1994, this Mi-24 retained the danger warning for the tail rotor in Cyrillic script. This 'Hind', now flown by 331 VRLt at Prerov-Bochor, carries the Ispanka IR jammer.



This Mi-17 of 332 VRLt serves alongside the unit's sole Mi-8PP, Mi-9 and Mi-2S. All combat-role helicopters are part of 33 ZVL (helicopter wing) based at Prerov-Bochor; 331 VRLt (the sole Mi-24 unit) also shares the wing base.



The more modern Mi-24V ('Hind-E') is also operated by 331 VRLt, wearing the old Soviet forces pattern colour scheme. This example carries the PTB-450 fuel tank on its wing pylon and Beryoza RHAWs antennas on its cheeks.



This Mi-8TB, seen at Zatec in 1992, was formerly operated by the Army Air Force consisting of the 51st and 11th Helicopter Regiments. The Mi-8TB force was divided equally at partition but the Czechs retained the only Mi-8PP.



An elderly L-29 of the former Czechoslovak air force. The Czech air force continues to operate 20 L-29s, the Slovak air force operating 16. The L-29 is very much a pilot's aeroplane, simple to fly and a good aerobatic mount.



Tactical transport duties are carried out by the four An-26s of LZSc 2 based at Praha-Kbely. The unit also operates the Let-410 and An-24V. Due to their low price, Antonov turboprops have made a comeback in the used civil market.



Easily recognisable thanks to its vivid colour scheme and cabin-door mounted winch, this is one of the SAR unit Mi-17s based at Plzen-Line. The aircraft are deployed throughout the country in 'Krystof' detachments.



Five An-24Vs are operated by LZSc2 at Praha-Kbely. The An-24V is a less versatile machine than the An-26, as it lacks a rear fuselage loading hatch. The type has been slated for replacement by the Let L-610 transport.



Another ageing Soviet design that has been retired by the Czech air force is the Antonov An-12, although a single example is still operated by 32/1 Letka of the Slovak air force based at Piestany as part of a mixed transport wing.

Air Power Analysis

Bomber Division, – later known as 1 Mixed Air Corps (1 Smiseny Letecky Sbor) – with HQ at Caslav, and it also incorporated the Attack Force (Bitevne Letectvo) and the Reconnaissance Force (Pruzskumny Letectvo). The Tactical Air Force had the task of eliminating enemy ground targets and providing air support for ground forces. It would operate against enemy command and control sites, airfield targets, lay anti-personnel mines, and provide air defence cover and reconnaissance over the battlefield.

Its main strength comprised three Fighter-Bomber Air Regiments (Stihacie Bombardovacie Letecky Pluk – SBoLP), including 9 SBoLP with MiG-21MFs at Bechyne, 20 SBoLP ‘Biskajsky’ Su-22M-4s at Namest nad Oslavou, and 28 SBoLP with MiG-23BNs at Caslav. An Attack Air Regiment (30 BiLP ‘Ostravsky’) operated Sukhoi Su-25Ks from Pardubice, where a single ECM-equipped Antonov An-26Z-I was also based, while 47 Tactical-Reconnaissance Air Regiment (47 PLP ‘Atlanticky’) flew Sukhoi Su-22R ‘Fitters’ with underfuselage camera pods and the veteran MiG-21Rs from Hradec Kralove.

Also administered by the 34th Fighter-Bomber Division was the CSAF’s Transport Force, with its equipment then divided between two bases. At Ostrava-Mosnov, 1 Mixed Transport Air Regiment (1 Smiseny Dopravni Letecky Pluk – SMDLP) was equipped with a pair of Antonov An-12s, all six twin-engined Antonov An-26 tactical transports, and about a dozen Let L-410 light turboprop transports. Up to 15 Mi-17 helicopters were also brought in as required, from 50 delivered. Czech air force L-410 procurement up to that time had comprised seven L-410Ms, three L-410UVPs and two VIP L-410VPU-E14s for transport; eight L-410Ts for paramilitary operations; and seven L-410FGs for photo-mapping.

VIP transport unit

Named after former president T. G. Masaryk, 3 Transport Air Regiment (3 DLP), based at Prague-Kbely, also had a mixed fleet that comprised six Antonov An-24RVs, about five Let L-410s, six or so Mi-8T/Mi-17s, some Mi-2s and, for VIP duties, eight Mi-8Ps, two Tu-154Bs, a Tu-134A, and a Yak-40. The Special Air Force controlled the three training regiments for both basic and operational training.

The Army Air Force (Pozemni Vojsko) was tasked with providing close support for the ground forces, using heavy battlefield and assault helicopters, command and ECM equipped helicopters and unmanned reconnaissance vehicles. Its four original helicopter regiments continued to operate mixed fleets of Mi-2, Mi-8T/Mi-17 and Mi-24 helicopters, and included 11 Vrtulnikovy Pluk (VrP) at Plzen-Line, 31 VrP at Bechyne, 51 VrP ‘Dr E. Benece’ at Prostejov, and 52 VrP ‘Rebelove’ at Havlickov-Brod. They were split, however, to add a further unit with ECM and communications roles, in the form of 1 Command & Reconnaissance Squadron (1 Letka Veleni a Pruzkumu – LVP), with Mi-2s, three Mi-8PPAs and a single Mi-9 at Plzen-Line.

That was the situation in late 1992, when the first stage of reorganisation was completed. Manned by 50,000 personnel, of whom a large number were conscripts, the full Czechoslovak air force inventory at that time, including aircraft held in reserve, under maintenance and operational

types used for ground training, was as follows:

Type	Fighter/AD	Tactical	Army	Training	Total
MiG-21	60	64	–	40	164
MiG-23	33	31	–	–	64
MiG-29	20	–	–	–	20
Su-22	–	57	–	–	57
Su-25	–	38	–	–	38
L-29	20	29	2	–	51
L-39	16?	8	33	–	57
An-12	2	–	–	–	2
An-24	6	–	–	–	6
An-26	6	–	–	–	6
An-30	1	–	–	–	1
Yak-40	1	–	–	–	1
Tu-134	1	–	–	–	1
Tu-154	2	–	–	–	2
L-410	18	4	5	–	27
Il-14FG	1	–	–	–	1
Mi-2	30	19	3	–	52
Mi-8	20	8	–	–	28
Mi-17	17	30	1	2	50
Mi-24	56	–	–	–	56

This breakdown gives an official total of 684 aircraft, including 129 classified as air defence fighters (surprisingly nominating 16 L-39s – presumably the ZAs – in that category); 263 tactical aircraft, totalling 392 combat types in all; about 100 armed helicopters; 126 trainers; and 30 transport and support aircraft. As a result of nationalist pressures the Czech and Slovak Republics reached an amicable agreement to become politically and economically independent on 1 January 1993, at which time it was decided that the aircraft would be shared between the newly emergent countries.

With the equipment of the other armed forces, the division was agreed to be in the approximate ratio of two-thirds to the Czech Republic and one-third to Slovakia. Exceptions to this were the prestigious MiG-29s, divided equally with the allocation of nine single-seat and one two-seat MiG-29UB aircraft to each air force. It was also agreed that the Czechs should keep all the MiG-23s.

Many problems were presented for both countries by this schism, notably due to the relocation of units from established bases. The Czechs, for example, lost their main training base and its facilities at Kosice, while Slovakia faced an acute shortage of military airfields resulting from the loss of access to the many Western-facing air bases built up in Bohemia and Moravia. The Czechs also faced problems in achieving personnel totals of 36,959 for the newly-combined air force and air defence forces (Ceske Letectvo a Protivzdušna Obrana – CLPO), which also came into official existence on 1 January 1993, since about 50 per cent of its original personnel were of Slovakian origin.

The ‘new’ Czech air force

Under the previously agreed distribution arrangements, the Czech Republic was left with 227 combat aircraft, comprising about 80 MiG-21, MiG-23MF/ML and MiG-29 air defence fighters; 72 MiG-21, MiG-23BN and Su-22 fighter-bombers; 25 Su-25 ground-attack aircraft; 24 MiG-21R and Su-22 reconnaissance fighters; and 26 MiG-21 combat trainers. It was also allocated 122 Mi-2, Mi-8/17 and Mi-24 helicopters, of which about half could be regarded as first-line equipment. Completing its scaled-down inventory were 32 An-12, An-24, An-26, Tu-134 and Tu-154 transports, 30 L-410 utility aircraft, and 76 L-29 and L-39 jet trainers.

These aircraft were consolidated at six main air bases, involving some shuffling of those units not disbanded by then and of their equipment. Namest was still the home of 20 SBoLP’s Su-22s, but it was joined by the Su-25s and L-39ZAs of 30 BiHP from Pardubice. Caslav retained the MiG-23BNs of 28 SBoLP, but Pardubice became the base for the An-30, Avia 14FG, Let-410FGs and Mi-17s of the former Photo Mapping Group (FLS), which was redesignated 10 Liaison Regiment (10 SPOJZ). Pardubice also housed transport aircraft of the redesigned 36 SMDLP. Ceske Budejovice retained the MiG-23MF /ML/UMs of 1 SLP, as did Prerov, with its L-29s, L-39Cs and MiG-21MF/UMs of 1 Training Regiment (1 LSP). The MiG-29s of 11 SLP were still at Zatec, although this base was scheduled to close before the end of 1993.

Prerov was scheduled to accommodate all Czech MiG-21 units, and already housed those of the renumbered 4 SSLT, as well as the Mi-2, Mi-17 and Mi-24 helicopters of 11 VrP, 51 VrP, and SMVRP. Finally, Prague-Kbely housed the government transport aircraft of 3 DLP, augmented until late 1993 by a single civil-registered Presidential Ilyushin Il-62M, and the VZLU-30 service trials unit. The remaining training units from Kosice were relocated to Brno. An Air Defence Division (dPVO) took over seven regiments (PLRP) of SA-2, SA-3, SA-4, SA-5 and SA-6 SAMs in three Air Defence Brigades (PLRB), although one of these was disbanded in 1993.

Equipment changes

New equipment with which VZLU-30 had been involved during the transition period included the fifth prototype of the scaled-up 40-seat Let L-610M twin-turboprop transport. A requirement for eight to 12 L-610s was then being considered to replace the remaining four Czech An-24s and similar number of An-26s, although all procurement plans have been delayed and limited by major retrenchments in defence spending. These also affected planned deliveries to the Czech air force of upgraded Albatros lead-in fighter trainers, through the L-39MS programme.

Main feature of the L-39MS was replacement of the original Progress/Lotarev AI-25TL turbofan by its Slovakian-built Povaske Strojarne ZVL-developed DV-2 version of increased power. It also introduced hydraulic servo-operated aileron and elevator controls, and an integrated nav/attack system, including a digital computer, dual head-up displays and a multifunction cockpit display screen.

Although a production order was placed by the CLPO for the L-39MS, redesignated the L-59, with deliveries of 48 planned by 1995, procurement appears to have been limited to only six aircraft to date. These were delivered from late 1992 to the second squadron of 1 Training Regiment (1 Letecky Skolni Pluk) at Prerov, although supplies of 48 L-59E and 12 L-59T export versions with Western Bendix King avionics are continuing to Egypt and Tunisia, respectively. Two of the Czech L-59s were also passed to Slovakia in early 1993. Other new indigenous training equipment acquired by the Czech air force included five Zlin 142C primary trainers, which passed through VZLU-30 in mid-1994.

The L-59 provided the basis for the CK1.4 billion (\$53 million) development of a new



The sole An-30 'Clank' operated by the Czech air force performs verification flights as part of the Open Skies agreement in the CFE treaty. The aircraft, delivered in 1990, was once operated by a Bulgarian airline, Hemus Air.



The Let L-410M is another example of a successful indigenous design that has been widely exported. This aircraft served with 36 SMDLP 'Masaryka' based at Praha-Kbely.



This Let-410UVP of the former CVL was based at Ostrava-Mosnov, with the 4444 Regiment on light transport duties. The addition of canary yellow to the camouflage was presumably to aid conspicuity when flying at low level.



Also a capable STOL aircraft, the single Let-610 is operated from Praha-Kbely. The type will probably be ordered following governmental approval of a purchase in April 1995; export prospects for the type are also good.



Seven Let-410FGs with this bright red and white scheme replaced the sole Il-14 in Czech service in the mapping and survey role. These aircraft have a glazed nose and fewer cabin windows than the Let-410M passenger aircraft.



The Zlin 142C is one of a small number of new aircraft joining the Czech forces, the latest in a line of very successful Zlin trainers. The aircraft is also used by Slovakia's VSL training school at Kosice, alongside Zlin 143s and 526s.



Above: Operated by one of the dispersed 'Krystof' SAR detachments, this Mi-2 is one of 36 on strength.

Below: The Mi-2 is also operated by 33 ZVL at Prerov-Bochor, as well as 31/4 and 34/4 Letka in Slovakia.



This unusual colour scheme was reserved for the Mi-2s of the Zachranná Služba (border guards). This unit has been increasingly busy since the late 1980s as many 'economic refugees' seek a new life in Western Europe.



single-seat multi-role version of the well-tried Albatros, to meet a CLPO requirement for a Mach 0.82 light attack aircraft with a maximum take-off weight of up to 8000 kg (17,637 lb), including a 2340-kg (5,159-lb) combat load. Intended to replace the MiG-21 and other Czech combat aircraft, the new L-159 is a key item in a new five-year defence programme, for which funding of some CK120 billion (\$4.53 billion) has been allocated for CLPO modernisation by the turn of the century. Procurement is planned of 72 L-159s, powered by a 6,300-lb (28-kN) thrust AlliedSignal/ITEC F-124-GA-100 non-afterburning turbofan, and employing an advanced MIL-STD 1553B databus, from a team led by Rockwell International.

This is also expected to include FIAR, to provide a lightweight pulse-Doppler radar; AlliedSignal multi-function colour liquid-crystal displays, air data computer and APX-100 IFF; a Flight Visions FV-3000 HUD; Honeywell H-764G integrated GPS/INS; a GEC-Marconi Defence Sky Guardian 200 radar-warning receiver; and Vinten Vicon countermeasures dispensing system. A 33-month development programme is planned for the L-159 after a prototype first flight scheduled for April 1996, leading to production deliveries between late 1998 and 2003.

A two-seat lead-in fighter trainer version of the L-159 is also envisaged, and the first of two flight prototypes planned will be in this configuration. Given the necessary funding, L-159s could eventually comprise up to 75 per cent of the CLPO combat inventory, for an officially quoted overall cost for 72 aircraft of CK18 billion (\$680.8 million). Export orders are also being sought for the L-159, for which the break-even to cover R&D and production tooling costs has been quoted as at least 170 aircraft.

MiG-23s and MiG-29s retired

During 1993-94 a great deal of time and a considerable amount of energy was devoted to re-establishing the CLPO as a credible and effective air arm. Like the smaller Slovak air force, it took the key organisational decision to complete its move towards a Western structure with commands, groups, wings, squadrons and flights. Initially, however, the air force and air defence units were organised into one mixed air corps, two air defence divisions, one transport regiment and a training regiment. Following the Czech Republic's political aims of eventually achieving NATO membership, the CLPO also linked its reorganisation with moves away from future arms and equipment procurement from Russia, while at the same time coping with further reductions of up to 35 per cent in the Czech armed forces.

Major savings were planned on 18 July 1994, from the withdrawal from CLPO service of its nine MiG-29s, following the loss in March of that year of its sole two-seat MiG-29UB in a ground fire. With an overhaul life for its Isotov RD-33 turbofans of only 400 flying hours, the MiG-29 proved not only difficult to maintain but also expensive to operate, particularly because obtaining spares from Russia, according to the Czech air force C-in-C, Major General Pavel Strubl, was "a serious problem."

The Czech MiG-29 fleet was also not of a viable size, particularly not to allow

cannibalisation, and Defence Minister Vilem Holan said that to keep them in service would have required the acquisition of at least 10 more. They have been placed in storage pending disposal, and have been offered to several MiG-29 operators, including India and Slovakia. So far, however, they have found no takers. With the departure of its MiG-29s and the transfer of its MiG-21MF squadron to 4 SSLT at Prerov, 11 SLP was disbanded and Zatec was closed by 16 October 1993.

Apart from older MiG-21s and its MiG-29s, the CLPO also withdrew its 12 MiG-23MFs and two MiG-23UBs interceptors from Ceske Budejovice in July 1994. This left only one regiment (1 SLP) with 16 MiG-23ML 'Flogger-Gs' and eight two-seat MiG-23UMs to transfer from there to Caslav by late 1994, in addition to the MiG-21MF/UMs of 4 SSLT (formerly 82 Independent Fighter Squadron - 82 SSLT) at the same base in service for Czech air defence. Ceske Budejovice air base was then due to close by January 1995.

MiG-23 upgrade

For a low-cost upgrade of its MiG-23's capabilities, and to examine the prospect of escaping the Russian spares supply situation, the CLPO initiated trials in mid-1995 of the MATRA 550 Magic 2 close-combat AAMs on two of its 'Flogger-Gs' at the French service flight-test centre (CEAM 330), Mont-de-Marsan. Six Magic 2s were flown on the underfuselage and inner-wing pylon positions of the MiG-23MLs in place of the R-23 (AA-7 'Apex'), R-60 (AA-8 'Aphid') and AAMs normally carried. Target acquisitions with Magic's infra-red seeker-head were successfully undertaken in captive tests from the MiG-23MLs, and were reportedly followed by two live air firings. Czech Defence Minister Frantisek Veprek described the Magic trials as "very successful," but no CLPO procurement has so far been mentioned.

Further equipment withdrawals in 1994 for budgetary reasons and to allow spares cannibalisation included the 30 or so remaining MiG-23BN 'Flogger-H' ground-attack fighters of 28 SBoLP and the tactical-reconnaissance MiG-21Rs from Caslav. The roles of both types were to be taken over by suitably-equipped Su-22M-4s, in a single consolidated attack/reconnaissance wing with two dozen Su-25s at Namest nad Oslavou.

Further cuts and reorganisation

In mid-1994, CLPO Inspector-General Major General Strubl announced plans to maintain an effective force of only 72 combat aircraft, 22 combat helicopters, 20 trainers, 10 fixed-wing transports and 10 transport helicopters, which apparently excluded reserve and spares source aircraft. These totals were well short of the Czech Republic's CFE-permitted 230 combat aircraft and 50 armed helicopters, and would be operated from five main air bases (Zakladnas Letecke - ZLs).

All CLPO units were also redesignated, and grouped within three main administrative commands. These included the Air Defence Inspectorate (ILaPVO), with its HQ in Prague, under which - despite its name - are grouped two transport squadrons at 6 ZDL, Kbely, as well as the Aviation Test Department (LZO) at 4 ZSL, Caslav. The CLPO's three-squadron MiG-21/MiG-23 fighter-interceptor wing is now

under the discrete command of 4 Air Defence Corps (4sPVO), at Caslav. This also includes two Air Defence Missile Brigades (PLR.B) at Slany-Drnov and Brno, and two AD Missile Regiments (PLRP) at Ostrava and Rozmital, controlling the CLPO's ground-based air-defence systems.

3 Tactical Air Corps (3 sTL) is the other main operational command and has its HQ and an SAR helicopter unit at Hradec Kralove. It controls the CLPO's Su-22s and Su-25s at 32 Tactical Air Base (32 ZTL), Namest, plus Mi-2s, Mi-8/17s and Mi-24s at 33 Helicopter Air Base, 33 ZVL (Prerov). 3 sTL also includes the main training base, apart from the HQ and Air Academy at Brno, at 34 ZSL, Pardubice. This would also house the An-30FG, L-410Ms, L-410FGs, An-26Z-1M and Mi-17Z-2 photographic survey fleet of the renamed 344 Reconnaissance Transport Squadron (344 PDL), minus the venerable Avia/I-14FG. Having entered Czech air force service in July 1958, this aircraft was finally retired on 7 April 1994 after 36 years and 6,935 flying hours.

An interesting addition to CLPO organisation at around this time was the appearance in its air order of battle of 345 Reconnaissance Drone Squadron (LtBPzP) within 3 Tactical Air Corps. This had apparently been in existence for about a decade, although with no previous public mention. It is equipped with Tupolev Tu-143 (VR-3) Reys unmanned aerial vehicles, originally delivered to Czechoslovakia in late 1984. The Tu-143 is powered by a single 1,340-lb (5.8-kN) TR-3-117 turbojet with a dorsal annular intake, plus a solid rocket-booster for ground launching. With only a small rear-mounted cropped delta-wing, the VR-3 has an operational radius of up to about 70 km (38 nm) at speeds of 875-950 km/h (472-512 kt), with camera, real-time TV or other sensor payloads. Recovery is by parachute and braking rocket. Other military UAVs are also under development by the Aeron company in Brno.

New fighters sought

In the early 1990s, the CLPO planned to halve its remaining MiG-21 fleet to about 40 operational aircraft, but proposed upgrading 24 to 36 of these with advanced avionics and nav/attack systems to keep them in effective service until at least 2005. Parliamentary approval was given for funding of CK330 million (\$12.5 million) towards this \$75 million programme in the five-year armed forces modernisation plan authorised on 21 November 1994, resulting in competing bids from Western companies headed by three Czech prime contractors.

These comprised Aero Vodochody linked with Israel's Elbit group, LOM/LOK (Letecke Opravarny Malesice/Kbely) maintenance and overhaul plants and Israel Aircraft Industries, and Let Kunovice with Sextant Avionique in France. Possible Russian interest was specifically excluded, in line with government policies for a break-away, as far as possible, from the influence of the Czech Republic's mighty and unstable eastern neighbour.

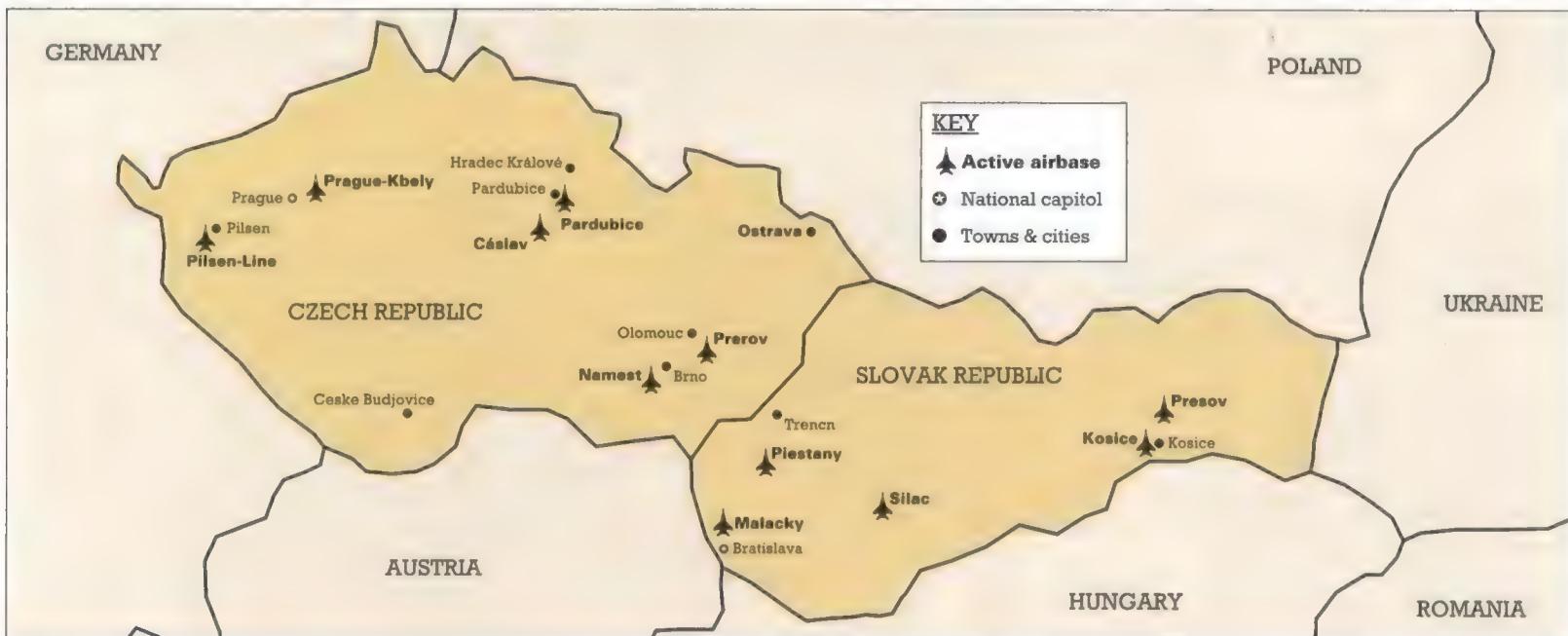
Modification was proposed of one or two prototypes following contractor selection but, in late 1994, further expenditure on the MiG-21 upgrade programme was frozen by the parliamentary defence and security committee, "to explore other options." These were mostly



Used in ejection seat trials, this MiG-21U belonged to the VZLU, the Czechoslovak test and trials centre. The aircraft carries a large number of star markings below the cockpit, each one representing a successful ejection test.



Another VZLU aircraft, this Yak-40 was also engaged in trials work from Kbely, including engine testing for the Walther engine of the Let 610. The OK-020 serial is a civil one ('class-B'), all military serials being the four-figure type.



Though not a cheap aircraft to operate, the MiG-29 is more capable than an F-16A. While other Eastern European nations eye Western aircraft, Slovakia has increased its MiG-29 force.



Slovakia has been a more enthusiastic operator of the MiG-29 than its sister nation, retaining the aircraft it received at partition and acquiring six more in 1994 (with nine more ordered since). This aircraft, a MiG-29UB, is one of three operated by 31/3 Letka based at Sliač.



This 'Fulcrum' wears a Western-style air defence grey colour scheme. In order to comply with CFE treaty limits and acquire more MiG-29s, several MiG-21s were retired after partition.



Malacky air base is home to 33LZ, a mixed fighter-bomber wing operating MiG-21MFs, L-29s, L-39ZAs, Šo-25s and Su-22M4s. This aircraft is flown by 33/1 Letka.



This Slovak air force Su-22M4 carries a KKR tactical reconnaissance pod on its centreline. These aircraft were formerly operated by the 47 PZLP (tactical reconnaissance regiment) which also operated three Su-22UM3Ks. Reconnaissance MiG-21Rs have been retired.

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concerned with the possible acquisition of surplus F-16s (including 24 offered by Belgium), F/A-18s or French air force Mirages, although initially the US State Department was reluctant to release equipment of this standard to the Eastern European states. Shortly before the 14 September 1995 deadline for MiG-21 upgrade submissions, however, major differences of opinion emerged on future fighter procurement policies between the Czech government and its Defence Ministry, and the project was stalled.

Whereas the former regarded any funds spent on 25-year-old MiGs as a complete waste, the Defence Ministry maintained that there was simply not enough money left in its budgets after paying for the L-159 to allow for anything but MiG-21 modernisation until at least 2003. This would be true, added the Ministry, even if it were given F-16s or something similar, because most of the associated CK60-80 billion (\$2.27-3.03 billion) costs would result from setting up the necessary technical support and training.

The MiG-21 and a future fighter

Against the wishes of the government, the Defence Ministry therefore proposed to go ahead with prototype upgrade modifications to one or more single-seat MiG-21MFs and a two-seat version, until around mid-1995. The US then agreed to release information on its surplus GD F-16A/Bs and MDC F/A-18s to some of the Visegrad countries, including the Czech Republic, Hungary, Poland and Slovakia. This again put the MiG-21 upgrade plans on hold, pending the findings of a joint Czech/US government team appointed to examine means of helping with the acquisition of modern combat aircraft.

Consideration is also being given to new types, and particularly the Saab JAS 39 Gripen, in which Hungary is already strongly interested, although only through commercial loan agreements to provide the necessary funding. Meanwhile, the MiG-21s and other Czech combat aircraft may be subjected to less ambitious upgrade programmes involving the installation of Western GPS and communications equipment, and replacing Soviet 'Odd Rod' IFF by Mk XII systems for NATO compatibility.

More re-equipment plans

The 1994 five-year armed forces modernisation plan also included provision "within two or three years" for the upgrade of CLPO Su-25 ground-attack fighters, and the installation of night-vision systems in its Mi-24 attack helicopters. Their availability has been low due to spares and fuel shortages, and the CLPO has been hard-pressed to meet its objective of improving the combat proficiency of its pilots by increasing their annual flying totals by around 33 per cent from 60 to 90 hours. This is almost half the annual total of most NATO combat pilots.

US military aid to the Czech Republic is also expected to include the supply through Foreign Military Sales funding of up to four surplus Lockheed C-130B Hercules. These are required, together with two or three large passenger jet transports, for the support of the recently-formed Czech rapid reaction brigade. The 40-passenger twin-turboprop Let L-610 transport was recommended in April 1995, by the Parliamentary Economic Committee as a replacement for the CLPO's five An-24RVs and

four An-26s at the turn of the century, although no Czech military orders have yet been reported.

Replacements are also being studied for the CLPO's three dozen Mi-2 twin-turbine light helicopters, some of which are used for search and rescue roles from Line with 3 Tactical Air Corps (3 sTL). These may possibly be upgraded, however, with more modern powerplants than their current Polish-built Isotov GTD-350 turboshafts. A CLPO requirement for basic trainer has led to evaluation of the PZL-130TBH, with a Czech Motorlet (Walter) M 601E turboprop, but firm orders are still awaited.

NATO integration

Priority is also being given in the five-year defence plan for the acquisition of new command, communications and control equipment for the national air defence ground systems. This is required as a further step towards the planned integration with NATO and neighbouring Visegrad nations, which are receiving \$25 million in US aid to upgrade and unify their ATC and air defence systems over a two-year period. In the former Czechoslovakia, the state-owned Tesla Pardubice ground-radar company was one of the most active in the world, having supplied over 800 (mostly Komar) units to the former Soviet bloc.

With the disappearance of this market, its 1992 successor, HTT Tesla Pardubice, has encountered major financial problems which have inhibited final development and sales of its two new Komar 2 and MCS-90 Tamara ground-

radar systems to meet current Czech and export requirements. Vehicle-mounted on an extending arm, Tamara is a passive system operating in the 0.82-18 GHz band, which uses triangulating group deployment for the detection and simultaneous tracking of up to 70 targets at up to 450 km (243 nm). Its manufacturer claims that its unique capabilities enable the system to detect, identify and track stealthy aircraft such as the F-117 and B-2.

CLPO strength

By 1 April 1995 the new Czech air force's aircraft inventory comprised: fighter/interceptor: MiG-21MF (69), MiG-21UM (20), MiG-21US (five), MiG-23ML (17), MiG-23UM (eight); fighter/ground-attack: Sukhoi Su-22M-4 (36), Su-22UM-3 (four), Su-25K (24), Su-25UBK (one); trainer/light ground-attack: Aero L-29 (20), L-39ZA (18), L-39C (20), L-39V (six), L-59 (four); trainer/primary: Zlin Z-142C (six); transport: Let L-410UVP (seven), L-410FG (five), L-410M (two), L-410T (five), L-610 (one), Antonov An-24V (five), An-26 (four), An-30 (one), Tupolev Tu-154B-2 (one), Yakovlev Yak-40 (one); helicopter/utility: Mil Mi-2 (36), Mil Mi-8TB (12), Mi-8S (five), Mi-8PPA (one), Mi-9 (one), Mil Mi-17 (26), Mi-17Z-2 (one); helicopter/attack: Mil Mi-24D (16), Mi-24V (20), Mi-24DU (two). The reorganised Czech Air Force and Air Defence (Ceske Letectvo a Protivzdušna Obrana), is under the command of Inspector General Pavel Strubl.

John Fricker

Ceské Letectvo a Protivzdušná Obrana

UNIT	TYPE	BASE	
Inspektor Letectvo a Protivzdušná Obrana (ILaPVO)			
• HQ Praha/Prague			
Letecký Zkusební Odbor (Aviation Test Department)			
LZO	MiG-21MF/UM, L-29, L-39	Plzen-line	
6 Základna Dopravního Letectva (6 Transport Air Base) (6ZDL)			
• Praha/Kbely			
61 Dopravní Letka (61 Transport squadron)			
61 dlt	Tu-134A, Tu-154B, An-24, An-26, L-410T, L-410UVP, L-610	Praha/Kbely	
62 Vrtulníková Letka (62 Helicopter Squadron)			
62 vrlt	Mi-2, Mi-8, Mi-1	Praha/Kbely	
3 Sbor Taktického Letectva (3 Tactical Air Corps) (3 sTL)			
• HQ Hradec Králové			
Letecké Středisko Záchranné Sluzby (SAR centre)			
LStrZS	Mi-2, Mi-17	Line	
32 Základna Taktického Letectva (32 Tactical Air Base) (32 ZTL)			
• Náměst. n. Oslavou			
321 Taktická a Průzkumná Letka (321 Tactical and Recce Sqn)			
321 tpzl	Su-22M4, Su-22M3U, L-39ZA	Náměst n. Oslavou	
322 Taktická Letka (322 Tactical Squadron)			
322 tl	Su-25K, Su-25UT, L-39ZA	Náměst. n. Oslavou	
33 Základna Vrtulníkového Letectva (33 Helicopter Air Base) (33 ZVrL) • Přerov			
331 Vrtulníková Letka (331 Helicopter Squadron)			
331 vrlt	Mi-24V, Mi-24D, Mi-24DU	Přerov	
332 Letka Dopravních a Speciálních Vrtulníku (332 Transport and Special Helicopter Squadron)			
332 ltsVrl	Mi-17, Mi-2, Mi-8PPA, Mi-9	Přerov	
41/42 Protiletadlová Raketová Brigáda (Air Defence Missile Brigade)			
41 plrb	Ostrava		
42 plrb	Rozmitál p. Tremsínem		
43/44/45/46 Protiletadlový Raketový Pluk (Air Defence Missile Regiment)			
43 plrp	Kromeríž		
44 plrp	Strakonice		
45 plrp	Brno		
46 plrp	Chomutov		
41/42/43 Radiotechnická Brigáda (AC&W brigade)			
41 rtb	Ceské Budejovice		
42 rtb	Brno		
43 rtb	Ceské Budejovice		
44 Radiotechnicky Pluk REB (ECM regiment)			
44 rtpREB	Ceské Budejovice		



About to take off from its home base at Sliac, this MiG-29UB may soon be part of a second squadron when the additional aircraft ordered from Russia arrive. The LaPVOS trains many foreign students, and even flies civilians ready to pay for a flight in this powerful fighter.



This Su-25 looks very mean in its sharkmouth paint scheme, and the numerous pylons under the wing show that the aircraft was clearly designed for bomb-carrying rather than speed. The Su-25 carries a 30-mm cannon with 250 rounds, as well as laser-guided munitions.



*Above and right:
Highly impressive
even by Slovak
standards, this 'beauty
and the bison' tail art
adorned an Su-25K
belonging to 33/2
Letka based at
Malacky.*

*Below: Despite the
presence of the
MiG-29, the old MiG-21
remains a vital type.
These aircraft would
be much more potent
if armed with more
modern missiles.*



No doubt a highly valued asset to the LaPVOS, the Su-25UBK is the only example of this variant on strength. The aircraft is fully combat capable, despite the slightly reduced performance caused by the rear cockpit.



Reminiscent of Soviet colour schemes, this MiG-21MF wears a typical polished metal finish with green dielectric fin top and nose cone. Typical armament is a pair of AA-8 'Aphid' missiles, though the MF can carry four.



The former Czechoslovak air force operated 17 MiG-21US conversion trainers at 1 Training Regiment at Prerov. The Slovak air force now operates its MiG-21 trainers in two squadrons (Letka 31/1 and 31/2) based at Sliac.

Letectva a Protivzdu Obrany-snej Slovenskej – LPVOS (Slovak Air Force and Air Defence Force)

As part of the Czechoslovakian conglomeration, the Slovak region was much less well developed militarily than its Czech partner. Its few airfields were much used by the Nazis during World War II – indeed, a Slovak air arm served as an adjunct to the Luftwaffe – but following the war, Soviet attention was lavished on the Czech ‘forward zone’. Today, the independent Slovak Republic maintains a small but surprisingly well-equipped air force and is looking both to the East and West for its future equipment.

Among the few military airfields ever built in Slovakia was Piestany, which has been an operational airfield since 1926 and which in 1928 accommodated the 3rd Czech Air Force Regiment. After the break-up of Czechoslovakia in 1939, Piestany became the principal fighter base for the Slovak air force and was active in March 1939 in the defence against Hungary. It went on to become an important fighter base in World War II, and was later used by various Czech air force operational units. Another base of similar 1926 vintage, which took its name from the adjacent village of Kuchya, has more recently formally adopted the name of the nearest town (and the local bombing range) and is now known as Malacky. In 1936 the Czech air force firing range was opened 10 miles (16 km) away at Nov Dvor and the airfield was used throughout the summer months as a temporary base for the squadrons using this range.

In March 1939, Kuchya/Nov Dvor was taken over by the Germans, who used it as a training base. After the post-war Communist coup, an air force firing range was established by the Soviet forces at Malacky in 1947. From 1 September 1963 Kuchya became an air training base, equipped with target-towing MiG-15s and later Aero L-39Vs, and was subsequently upgraded for permanent use by Slovakian Su-25s. While the upgrade was under way, the Su-25s were temporarily based at Trenčín. Renamed Malacky, Kuchya became fully operational by March 1995.

Sliac Air Base was constructed before World War II, and for the next 30 years was used by air force units of the Czechoslovak People's Army (CSPA). It was taken over by the USSR after the invasion of 1968, and used as a base for VVS combat aircraft and helicopters. After the Soviet departure in late 1990, the 81st Fighter Squadron of the 8th Air Regiment moved in from Brno, together with its support unit. In eastern Slovakia, Presov was primarily a maintenance airfield and, despite its wartime use as a fighter base, had not accommodated a front-line squadron for more than 30 years. Presov is now Slovakia's main military helicopter base.

With the post-war re-establishment of Czechoslovakia, Slovakia did not seek its independence until after the collapse of Communism. Its new air force was formed on

1 January 1993, when the two elements of the former nation officially went their separate ways.

An air force reborn

A commission of the Czechoslovakian armed forces had been established in September 1992 to apportion the division of military equipment between the two emergent nations. The approximately 2:1 equipment share agreement reflected the relative sizes and populations of the two former components, Slovakia's 5.32 million people being about half the total of the Czech Republic's and living in slightly under 50 per cent of the total Czechoslovakian area.

A three-phase programme set out to achieve the transfer of most in-service military material by 21 December 1992, followed by logistic and support equipment by 30 June 1993. For the newly-formed Slovak Air Force and Air Defence Force (Letectva a Protivzdu Obrany-snej Slovenskej – LPVOS), under the command of General Major Ing Stefan Gombik, the third and final phase ended on 31 December 1994, with the allocation and transfer of spares and stored aircraft, such as MiG-21-F13/PF/Us and Su-7s, and remaining ground equipment allocations.

Slovakia had to organise ongoing training programmes on all its aircraft in 1993, and set up a newly-required control and communications system. Significant improvements were also needed to the infrastructure of the air bases, including the provision of individual aircraft metal blister hangars for covered maintenance, as well as the domestic accommodation for both flying and support personnel. Since most of the military aircraft had been deployed in the Czech Republic, one of the main problems faced was relocating the personnel and their families in Slovakia.

LPVOS strength

Slovakia's one-third allocations resulted in a total of 228 aircraft of more than a dozen main types being received. Of these, about 125 could be classified as having a combat capability, while 26 trainers, 16 transports, 43 transport/utility helicopters and 19 attack helicopters were also included. Perhaps not entirely fortuitously, new CFE limits for Slovakia of 115 combat aircraft and 25 attack helicopters corresponded fairly closely with these totals. Not included in these

totals were about 20 MiG-21F-13 and MiG-21PF fighters, plus the Su-7s which had been previously retired from Czech service and held in storage at Vodochody until transferred to Sliac in the equipment share-out, pending disposal or destruction.

The precise Slovak active air inventory at that time therefore comprised: fighter/interceptor/reconnaissance: MiG-21MF (49), MiG-21R (eight), MiG-21UM (11), MiG-21US (two), MiG-29 (nine), MiG-29UB (1); fighter-ground-attack: Sukhoi Su-22M-4 (18), Su-22UM-3K (three), Sukhoi Su-25K (12), Su-25UBK (one); trainer/light ground-attack: Aero L-39ZA (nine), Aero L-39MS/L-59 (two); trainer/basic: Aero L-29 Delfin (16); trainer/advanced: Aero L-39C (eight); target-towing: Aero L-39V (two); transport: Let L-410UVP (two), L-410FG (two), L-410M (two), L-410T (three), Antonov An-12BP (one), An-24V (two), An-26 (two), Tupolev Tu-154B-2 (one), Yakovlev Yak-40 (one); helicopter/utility: Mil Mi-2S (17), Mi-8TB (nine), Mi-8S (three), Mi-17 (17); helicopter/Elint/ ECM: Mi-8PPA (one), Mi-17Z-II (one); helicopter/attack: Mil Mi-24D (eight), Mi-24V (10), Mi-24DU (one).

Deployment of this force was not easy since – as the eastern component of the former Czech union – Slovakia was the location of only about five main air bases. With their respective units and equipment, these included Sliac, with 1 Fighter Regiment (1 SLP) of MiG-21MF/UMs, MiG-29s and L-39ZAs. Piestany housed 2 Mixed Regiment (2 ZmDLP), which in addition to a transport aircraft and a utility Mi-2, Mi-8 and Mi-17 helicopter squadron, included a third squadron (3 letka) with Su-25K/UBK and L-39ZA attack aircraft. Kuchya/Malacky accommodated the MiG-21MF/R/UMs and Su-22M-4/UM-3Ks of 3 Fighter-Bomber Regiment (3 SBoLP), while Presov became the LPVOS' main helicopter base, with three squadrons in 4 Helicopter Regiment (4 VrP) operating Mi-24D/Vs, Mi-8/17s and Mi-2s, respectively. Kosice retained its original training function with some of the L-29s, L-39C/ZAs, target-towing L-39Vs, Mi-2s and Let 410s of 1 LSP in 5 Air Training Regiment (5 LSP).

More MiG-29s acquired

As is evident, the LPVOS effectively took over several of the main elements of former Czechoslovakian air force units, initially retaining their original designations. Exceptions to the one-third/two-thirds equipment allocations between Slovakia and the Czech Republic were the latter's retention of all air defence MiG-23s, and the equal division of the 18 recently-delivered MiG-29s and two two-seat MiG-29UBs between the two emergent nations. Slovakia also retained the sole MiG-29 flight simulator at Sliac; to improve the operational viability of its 'Fulcrum' squadron, this small nation took delivery of five additional single-seat MiG-29s and one MiG-29UB from Russia in 1994.

This was facilitated by Slovakia's favourable trade balance with Russia, which also resulted in the mid-1995 LPVOS decision to negotiate the acquisition of another two-seat and seven more single-seat MiG-29s. Delivery was due by the year's end with an eye to equipping a second 'Fulcrum' squadron at Sliac, increasing Slovakia's overall MiG-29 strength to 21 single-seat and



Responsible for training and light attack duties, the Aero L-39ZAs bridge the performance gap between Slovakia's L-29s and its front-line jets, as well as having a useful combat capability of their own.



Painted in the colours of the 'Biele Albatrosy', the Slovak aerobatic team, this L-39 is flown by a select group of VSL instructors. The team is based at Kosice, home of the Fighter Pilot's Academy.



These Slovak Mi-24Vs have the late-model fully-faired ASO-2V chaff and flare dispensers fitted just behind the national insignia. The Mi-24V has provision for twin 9M114 Sturm (AT-6 'Spiral') anti-tank missiles on the wing pylons and a new IFF aerial.



This Mi-17 is operated by 34/3 Letka at Presov, along with a number of older Mi-8s. Presov is now the Slovak air force's primary helicopter base, following extensive repair work to the facilities.



This Mi-17 is operated by 34/3 Letka at Presov, along with a number of older Mi-8s. Presov is now the Slovak air force's primary helicopter base, following extensive repair work to the facilities.



The substantial aerial array at the rear of the cabin identifies this Mi-8 as the PPA communications and signal jamming variant. This is the only example in the LaPVOS, used by 32/2 Letka at Piestany.



Likely to give many more years of service, the Mi-8T serves with 32/2 Letka at Piestany. The most numerous medium transport helicopter in the world, the Mi-8 is well known for its reliability and strength.



Painted in a suitably civil-looking colour scheme, this Mi-8 is part of the government transport flight based in Bratislava. In the background is the Tu-154B-2 transport aircraft of 32/1 Letka, which operates at this base although its unit is based at Piestany.

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three two-seat trainer versions. To maintain its combat strength below CFE limits, the LPVOS retired a number of its MiG-21MFs, and all six of its reconnaissance-equipped MiG-21Rs carrying alternative pod-mounted optical, radar or ESM sensors from 3 letka of 1 SLP at Sliac, in late 1994 and 1995. This unit also operated 11 two-seat MiG-21UMs and six L-39ZAs as an operational conversion unit, a role apparently taken over by 2 letka in the same regiment.

Tactical reconnaissance was then handled by Su-22M-4s with KKR sensor pods, transferred from the Czech 47 Tactical Recce Regiment (47 PZLP), plus three two-seat Su-22UM-3Ks operating with 1 letka of 3 SBoLP at Kuchyna/Malacky. This base also had a base flight of four L-29s and two L-39ZA jet trainers. On 24 September 1994, 3 Fighter-Bomber Regiment was expanded by the transfer of the 12 Su-25Ks and one two-seat Su-25UBK, plus two L-39ZA armed trainers, from 2 Mixed Regiment, which had been on long-term detachment at Trencin, to form 2 letka/3 SBoLP.

MiG-21 survivors

This fighter-bomber regiment still operated two squadrons with about 30 AA-2- and AA-8-armed MiG-21s, from 60 remaining in Slovakian service and including a dozen two-seat MiG-21UM/US combat trainers. These also equip the single MiG-21MF squadron flying 16 'Fishbed-Js' alongside 1 SLP's MiG-29s at Sliac, and 56 are being considered for possible upgrade programmes to extend their operational capabilities and service lives into the next century. With the departure of its Su-25s, Trencin reverted to non-operational status, as the LPVOS aircraft maintenance centre, and for communications aircraft and helicopters. Repair and overhauls of L-29s, L-39s, Su-22s, Su-25s and Czech MiG-23s are undertaken at Trencin by the LOT (Letecke Opravovne Trencin) company.

Inventory shortages resulted in an additional example of equal distribution between the Czech and Slovak air forces, including ECM/Sigint helicopters. These comprised only a single Mil Mi-8PPA (Pastanovchik-Pamech Aktivniye) 'Hip-K', with six cruciform dipole antennas on each side of the fuselage for active communications and signal jamming, plus ventral heat exchangers; and a locally-designed Mi-17Z-II carrying paired cylindrical electronics containers flanking its cabin sides to locate and analyse hostile radio and radar transmissions. In Slovakia, these equip a Command Flight of the Defence Staff in 32/Letka at Piestany, although most LPVOS helicopter activity is concentrated at Presov.

When this airfield was selected on 12 November as the Slovak air force's primary helicopter base, a great deal of work was required on the buildings, roads, taxiways and runways, and is only now being completed. On 1 January 1993, it was opened as 4 Air Base of the LPVOS to accommodate 4 Helicopter Regiment (4 VrP) with a squadron each of 10 Mi-2s, two dozen Mi-8/17s, eight Mi-24Ds, one Mi-24DU, and nine AT-6-armed Mi-24Vs.

As the remaining main element of the LPVOS, the Flying Training Centre (Vycvikove Stredisko Letectva - VSL) at Kosice reports directly to 3 Group Headquarters at Zvolen. The well-established VSL has its roots in the air training

school that was first formed at Prostejov in Moravia on 1 November 1954. The centre moved to several bases before arriving at Kosice on November 1959. It underwent several name changes, including Higher Air School, 2nd Air Training Regiment and 1 LSP, in the process of becoming the main East European flight-training centre for Communist bloc and Third World countries.

It was equipped to provide multi-lingual training in English, French, Hungarian and Russian, as well as Czech and Slovak, and its fleet of Aero L-29s and L-39s graduated pilots over many years from such countries as Algeria, Angola, Egypt, Ethiopia, Hungary, Libya, Nigeria, Syria, Uganda and Vietnam. On 1 January 1993 it was renamed 5 Air Training Regiment, and three years later it became an integral part of the Air Force Training Centre. These days it concentrates on providing about 120 hours of basic and advanced training for all Slovak air force pilots and navigators on its 12 L-29, 10 L-39C, two L-39MS/L-59 and three L-410UVP/T aircraft, after some 60 hours of initial flying on Zlin 142s, 143s and 526s of the Kosice Flying Club at the same base. Helicopter pilots undergo their rotary-wing conversion on Mi-2s of 4 VrP at Presov.

Comprehensive training

Students undergo their academic training at the Military Air Force University 'General M. R. Stefanika' (Vysoka Vojenska skola Letectva - VVsL), which is situated in the town of Kosice. Originally founded at Cheb in 1918, it was reformed on 1 September 1973 under a Presidential decree, and extended its training facilities to include ground personnel. Over the following years it changed its organisation, and in 1991 was divided into two parts for academic teaching and air force training. After the division of Czechoslovakia the university was given its current title and became the professional training institution for pilots, navigators, aircraft technicians and engineers, providing degree and post-graduate academic and technical courses.

Kosice is also the home base of Slovakia's national aerobatic display team, the 'White Albatrosses' ('Biele Albatrosy'), which comprises seven white-painted L-39s flown by instructors from the VSL. These have appeared with some success at a number of international displays, including the IAT at Fairford. Having training capacity to spare after Slovakia's break with the Czech Republic, Kosice also pioneered unusual commercialisation plans in 1993 by opening its facilities to the newly-formed International Fighter Pilots Academy.

This Western-operated civilian organisation – also referred to as 'the 55th Training Squadron of 5 Training Wing' – had a contract with the Slovak air force to offer conversion training on various LPVOS aircraft, including the Zlin 142, L-29, L-39, MiG-21UM and even the MiG-29UB, to all and sundry for course fees of \$16,000-35,000. Individual flights were available for much less, those on the more advanced aircraft involving Sliac-based MiG-21s and MiG-29s. Quite a few clients – mostly well-heeled Western warbird enthusiasts – took advantage of these facilities while they were available.

In keeping with its increasingly Western orientation, the Slovak Ministry of Defence also set in motion a plan for the restructuring of the

Slovak forces to produce a more independent air arm, with its day-to-day organisation reflecting that of NATO member countries rather than the former Soviet Union. This began on 1 November 1994 and was completed by 1 March 1995, involving a new structure based on HQ, air bases, groups, wings, squadrons and flights. The current organisation, adopted on 1 January 1995 under the Slovak Air Force General Staff (Stab Letectva a Protivzdu-snej Obrany Generalneho Stabu - SLa PVO GS), with HQ at Trencin, is administered for day-to-day operation through 3 Air Group and Air Defence (3 zbor Letectva a Protivzdu-snej Obrany - 3zL a PVO) from Zvolen.

John Fricker

Leteckva a Protivzdu Obrany-snej Slovenskej - LPVOS

UNIT	TYPE	BASE
31 Letecka Zakladna - 31 LZ	(31 Air Base)	Sliac
31 Stihacie Letecke Kridlo - 31 SLK	(31 Fighter Air Wing)	
31/1 Letka	(31/1 Squadron)	MiG-29, MiG-29UB
31/2 Letka		MiG-21MF, MiG-21UM
31/3 Letka		MiG-21MF, L-39ZA
31/4 Letka		L-410, Mi-2, Mi-17
32 Letecka Zakladna - 32 LZ	(32 Air Base)	Piestany
32 Zmiesany Dopravny Kridlo - 32 ZmDK	(32 Mixed Transport Wing)	
32/1 Letka		An-12BP, An-24V, An-26, L-410M/FG/T/UVP, Tu-154B-2*, Yak-40
32/2 Letka		Mi-2, Mi-8PP/PPA/T, Mi-17/Z-II
33 Letecka Zakladna - 33 LZ	(33 Air Base)	Malacky
33 Stihacie-Bombardovacie Letecke Kridlo - 33 SBolK	(33 Fighter-Bomber Air Wing)	
33/1 Letka		Su-22M-4/UM-3K, L-29
33/2 Letka		Su-25K/UBK, L-39ZA
33/3 Letka		MiG-21MF, L-29
34 Letecka Zakladna - 34 LZ	(34 Air Base)	Presov
Vrtulnikovy Kridlo - 4 VrP	(34 Helicopter Wing)	
34/1 Letka		Mi-24V
34/2 Letka		Mi-24D
34/3 Letka		Mi-8, Mi-17
34/4 Letka		Mi-2
Vycvikove Stredisko Letectva/VSL	(Flying Training Centre)	Kosice
5 Letecky Skolsky Pluk - 5 LSP	(5 Air Training Regiment)	
5/1 Letka		L-39C/MS/V
5/2 Letka		L-29
5/3 Letka		L-410UVP-T
Vysoka Vojenska skola Letectva/VVsL 'Gen M.R. Stefanika'	(Military Air University)	Kosice

By the end of 1995, the LPVOS aircraft inventory had changed to: fighter/interceptor/recce: MiG-21MF (45), MiG-21UM (10), MiG-21US (two), MiG-29 (20), MiG-29UB (three); fighter-ground-attack: Sukhoi Su-22M-4 (17), Su-22UM-3 (three), Sukhoi Su-25K (12), Su-25UBK (one); trainer/light ground-attack: Aero L-39ZA (nine), Aero L-39MS/L-59 (two); trainer/basic: Aero L-29 Delfin (16); trainer/advanced: Aero L-39C (eight); target-towing: Aero L-39V (two); transport: Let L-410UVP (two), L-410FG (two), L-410M (two), L-410T (three), Antonov An-12BP (one), Antonov An-24V (two), An-26 (two), Tupolev Tu-154B-2 (one), Yakovlev Yak-40 (one); helicopter/utility: Mil Mi-2 (17), Mil Mi-8TB (nine), Mi-8S (three), Mi-17 (17); helicopter/Eltint/ECM: Mi-8PP (one), Mi-17Z-2 (one); helicopter/attack: Mil Mi-24D (eight), Mi-24V (10), Mi-24DU (one).

Like all the former Warsaw Pact air arms, the Slovak air force operates on a very tight budget. The cost and availability of fuel means that flying hours are restricted. Currently, each operational base only has two 'flying days' each week. Additional time is made available for the display practices by the 'Biele Albatrosy', and for Major Ivan Hulek, the 1995 MiG-29 solo display pilot who is the commanding officer of 31/1 Squadron at Sliac.



This An-26 is one of a pair operated by 32/1 Letka at Piestany. Like its Czech counterparts, the aircraft retains the camouflage paint scheme that it wore before partition. The aircraft have a large observation bubble behind the cockpit.



The mighty An-12 is the largest turboprop operated by the LaPVOS, and is also the single example in use, the Czechs retaining the other (2105). It is operated from Piestany by 32/1 Letka, the combined transport squadron.



Two An-24Vs are also used by 32/1 Letka. The An-24 seats up to 50 passengers, and can also carry a 4612-kg payload, although the cargo-carrying role is usually the preserve of the An-26 which has superior freight-loading facility.



The other Piestany-based An-24 wears this very smart three-colour livery with its base name on the nose. Unlike the Czech Republic, Slovakia does not plan to replace these aircraft with Let-610s, mainly due to funding shortages.



The government flight's sole Tu-154B operates from Bratislava-Ivanka international airport. It carried the civil registration OK-BYO and air force style national insignia. The first Tu-154B was built in 1977, and the aircraft is thirsty compared to new designs.

Below: This Mi-2 probably belongs to 34/4 Letka at Presov. Helicopter pilots undergo conversion training on this type, a useful asset given that all the other Mil helicopters were designed to have a similar layout.



Left: This Let 410UVP is another Piestany-based aircraft belonging to 32/1 Letka. The squadron operates two Let-410UVPs as well as the two photo-mapping FG variants and the Let 410Ms.



As well as the border guard and the air force, the Mi-2 is also operated by the police for observation duties.



Left: VIP transport of important personnel is carried out by a single Yak-40, also part of 32/1 Letka. The Yak-40 is powered by three Ivchenko turbofans.

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